GLOBE YEAR 4 EVALUATION

Evolving Implementation Practices

December 31, 1999

Prepared for:

Global Learning and Observations to Benefit the Environment (GLOBE)
744 Jackson Place
Washington, D.C. 20503

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SRI International

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Executive Summary

By June 1999, nearly 7,000 schools in 84 countries had participated in Global Learning and Observations to Benefit the Environment (GLOBE), an international environmental science research and education program. In the roughly 5 years since the program began training teachers, some 10,000 teachers, 2,000 of them from schools outside the United States, have received intensive training on how to implement the program.

GLOBE students are involved in authentic science investigations, led by GLOBE scientists who have designed the data collection protocols and review and analyze the student data. Since the start of GLOBE data collection on Earth Day 1995, GLOBE students have used data entry forms on the World Wide Web to submit their measurements to a central archive, where they are combined with data from other schools.

GLOBE provides a scientific framework and educational resources; it is neither a curriculum nor a fully specified educational intervention. The GLOBE Program provides a set of data collection protocols in four investigation areas: Atmosphere, Hydrology, Soil, and Land Cover/Biology. The protocols specify GLOBE's requirements for data collection, including times when measurements are to be taken, the instruments needed, and procedures to ensure accuracy of data and consistency across study sites.

In addition to specifications for the measurement protocols, the GLOBE Teacher's Guide contains related learning activities for classroom use. The learning activities are designed to help students understand the scientific context of their data collection activities, to encourage student analysis of GLOBE data, and to promote original inquiry.

Through these activities, GLOBE seeks to fulfill a three-part mission:

- *To enhance the environmental awareness of individuals worldwide;*
- *To increase to scientific understanding of the Earth; and*
- *To improve achievement in science and mathematics education.*

Other than requiring careful adherence to the data collection protocols, GLOBE gives U.S. schools and international partner programs complete latitude in determining the (K-12) grade levels and classes in which to implement the program, the learning activities to provide, and the way in which the program will be integrated with the local curriculum.

Before their students can enter data on the GLOBE database, teachers must complete a training program in which they learn how to conduct the GLOBE protocols and gain experience with the learning activities in the GLOBE Teacher's Guide. When GLOBE U.S. teacher training began in March 1995, teams composed of a facilitator, two scientists, two technology specialists, and two educators, working under contract, conducted sessions at NASA Space Grant university sites around the United States. Training sessions followed an intense 3-day schedule (with sessions most evenings), with an optional fourth practice and refresher day. Training content focused on discussion and conduct of each of the data collection protocols; it also included exposure to some of the GLOBE learning activities and practice with the Internet and with using software for manipulating satellite images. Typically, each school sent one teacher for GLOBE training.

Once initial successful implementations were under way in the first cohort of GLOBE schools, the GLOBE Program turned to consideration of how it could feasibly extend its influence to more teachers and students. Early feedback from the field was making apparent the level of challenge a single teacher faced in trying to implement all the many aspects of GLOBE. In some cases, expected equipment or Internet connections were not in place. In other cases, teachers had trouble fitting GLOBE into the curriculum they were expected to cover in their particular course. Sometimes, getting students to a study site or providing supervision for students conducting activities in two different locations was an issue. Moreover, the GLOBE Program realized that the small number of individuals providing GLOBE training could not possibly provide ongoing advice, encouragement, and assistance to all the GLOBE teachers being trained across the United States.

Starting in its second year (spring 1996), the GLOBE Program began encouraging schools to send multiple teachers for training. The program believed that having more than one teacher participate in each school would improve prospects for long-term participation and data reporting. In the 1997-98 academic year, GLOBE began using a "franchise" model to provide some of its teacher training. Under the franchise model, the GLOBE Program enters into a no-exchange-of-funds partnership with a university, school district, science center, or other entity interested in providing GLOBE training in its local area. The franchise partner sends those individuals who will be providing training for teachers to a GLOBE training workshop and receives GLOBE materials (Teacher's Guides) for distribution to the teachers it trains. Franchises can leverage the federal investment in the program's scientific, technical, and educational infrastructure but are responsible for paying their own operating costs.

Although GLOBE still offers some training sessions conducted at selected sites across the United States, by 1997-98, the majority of U.S. teachers receiving GLOBE training were trained through franchises.

During the same period that franchise training has been becoming more central to the GLOBE Program in the United States, participation levels among international GLOBE partners have been on the rise. Whereas teachers trained by international partners were roughly 20% of the total teachers trained in GLOBE by fall 1997, they represented 30% of the total trained during 1998-99. Like U.S. franchises, international partners work within the framework of the distributed scientific investigations set up for GLOBE but have complete freedom to choose which schools to recruit, how to schedule their teacher training, and what supports to provide for their trainees.

The Evaluation

SRI International was selected through a competitive grant process to provide GLOBE's evaluation component. This report focuses on evaluation activities and findings from 1998-99, the fourth school year of GLOBE implementation. (Evaluation reports for the three prior years are available from the Resource Room on the GLOBE Web site at www.globe.gov.)

Because of the rising importance of U.S. and international partners in implementing GLOBE, SRI chose to focus the majority of this year's evaluation activities on franchise and international partner practices. A GLOBE Partner Survey was developed and sent to coordinators of franchises and international partner programs that were active as of March 1999. The survey focused on partner recruiting, training, and follow-up support practices, as well as the challenges partner organizations face and the strategies they are using to surmount those challenges.

For U.S. franchise partners, responses provided on the survey were supplemented by more qualitative data collected through site visits to four active franchises. At each franchise, SRI researchers observed teacher training sessions, interviewed participating teachers and franchise staff, and visited schools of teachers previously trained by that franchise to observe GLOBE activities.

For international partners, site visits were beyond the scope of the evaluation grant. Instead, Partner Survey responses were supplemented from information gained through face-to-face interviews conducted with country coordinators or their representatives attending annual GLOBE meetings in the United States over the past 3 years.

In addition to the Partner Survey and franchise site visits, 1998-99 evaluation activities included the development and pilot testing of a two-part Web-based student assessment. The first portion of the assessment was aimed at measuring students' environmental awareness, defined as an understanding of how global processes interact to form a dynamic system whose workings are visible to students at both the global and local levels. Given an environmental scene, students were asked to describe the important features of the environment. Students were first given only this very general direction and later asked to describe the scene again with particular attention to the water cycle. Student responses were scored for the number of inferences they contained concerning underlying causal mechanisms and for the inclusion of specific "big ideas," identified as important by national science standards and by the environmental scientist working with the evaluation team. This portion of the assessment was based on pilot work on environmental awareness conducted in Year 3. Year 4 activity tested whether the approach to eliciting evidence of students' environmental awareness—which had included probing for responses of individual students by researchers conducting one-on-one interviews in Year 3—could be implemented by computer with small groups of students.

The second portion of the Web-based pilot assessment called on students to demonstrate their skill in data analysis and problem solving. To provide a motivating context within which students could demonstrate their skills, a hypothetical task was developed calling on students to choose the best of five candidate sites for the Winter

Olympic Games. They were informed that their choice was to be based on climate data provided to them and on a set of constraints set forth by the Olympic Committee. In addition to making a selection, students were instructed to develop a persuasive presentation for the Olympic Committee, laying out the arguments and supporting data for their selection. Students were scored not just on the quality of their site selection but also on the quality of their arguments and the relevance of the data they chose to cite and graph in support of their recommendation.

The Findings

Surveys were received from 97 active GLOBE partners (52 U.S. franchises and 45 international partners), for a 60% response rate. Responses to the Partner Survey indicate that GLOBE partners now think of schools and school districts, rather than individual teachers, as their most important recruiting targets. More than 30% reported that they *require* schools to send more than one teacher to GLOBE training.

GLOBE partners are setting other requirements for participation, as well. More than half require Internet access at the school or classroom level as a prerequisite, and 44% require a commitment to obtain the needed measurement equipment. More than a third require the school's principal to endorse the teacher's attendance at training, but only two international partners (and no U.S. franchises) reported requiring the principal to actually attend some portion of the training.

One of the primary motivations for moving to a franchise training model within the United States was the assumption that organizations working with schools and teachers in their own geographic regions could provide a fuller, more continuous set of supports for the teachers they train. Responses to the Partner Survey support this assumption. More than 60% of GLOBE partners are providing their trainees with instrument kits, greatly reducing one of the barriers to implementation cited by teachers in previous years' surveys. Sixty percent of the partners have mapped GLOBE activities onto the contents of state or local curricula and assessments, helping their teachers to see how GLOBE can achieve objectives they already have. Almost as many (57%) reported giving teachers assistance in setting up and using computers for GLOBE. Thirty-seven percent of partners (and 47% of international partners) reported giving their teachers assistance in getting Internet connections.

GLOBE partners do not leave their teachers to "sink or swim" after training. Eighty percent reported maintaining personal contact through phone calls or e-mail after the training has concluded. Sixty-three percent reported that franchise staff go out to the schools of teachers they have trained, and 62% host meetings or conferences where previously trained teachers can share experiences. Forty-eight percent host refresher training sessions.

Logically, we would expect that, over time, those GLOBE partners with more active follow-up will have larger proportions of the teachers they have trained fully implementing the program. Our attempt to examine this issue empirically was limited by the relatively short history of franchise training; only 34 of the U.S. franchises responding to our survey had trained teachers from five or more different schools by spring 1999. We divided this subsample into those providing higher and lower levels of follow-up support. This preliminary analysis found that GLOBE franchises providing high levels of teacher follow-up have had 31% of the schools for whom they have trained teachers contribute data to the GLOBE database; for franchises with low levels of follow-up, the corresponding figure is 24%. As more franchises build up a significant number of schools for which they have trained teachers and enough time elapses for those teachers to be expected to have implemented the program, we will perform additional analyses addressing this issue.

The Partner Survey asked for information concerning the amounts of time devoted to various aspects of GLOBE in the partner's teacher training. Responses suggest that protocols continue to receive more time than learning activities in the training, but most partners spend at least some time on training the learning activities within each investigation. The much higher classroom implementation rates for Atmosphere protocols than for the protocols in other investigations (documented in earlier evaluation reports) cannot be attributed to more coverage in training. Protocols in Soil, Land Cover/Biology, and Hydrology were all more likely than those in Atmosphere to get more than 3 hours of training coverage. On the other hand, 15% or more of partners reported spending less than an hour on protocols in Land Cover/Biology and in Soil, a time allocation that would certainly not permit thorough coverage of all the protocols in those investigations. The total amount of time devoted to training reported by GLOBE partners averaged 36 hours.

GLOBE provides its partners with training for their trainers, materials they can use in training teachers, and the support structure of the international science and education program. It does not provide operating funds. All GLOBE partners, then, must find ways to leverage other teacher education and science outreach programs to fulfill their goals. Forty-seven percent of all the partners responding to the survey, and more than half of the international partners, reported that fund-raising is a major challenge. At the same time, aligning GLOBE with other national and local initiatives and building on their networks of contacts are making it possible for partners to rise to this challenge. International partners especially are finding a variety of private-sector partners willing to support various aspects of GLOBE. Within the United States, other educational improvement efforts, such as the Eisenhower funds for improving mathematics and science teaching, Technology Innovation Challenge Grants, and National Science Foundation-funded systemic initiatives to improve mathematics and science education, are helping to support GLOBE teachers and franchise activities.

When asked to describe the biggest challenges they confront other than fund-raising, GLOBE U.S. franchise partners were most likely to describe needs for follow-up supports for the teachers they have trained. International partners were most likely to cite the challenge of gaining political and institutional support. Obtaining and maintaining equipment and getting scientists involved with GLOBE were frequently mentioned among both partner groups. Finally, U.S. franchises talked about the challenge of developing partnerships, and both types of partners talked about the need to align GLOBE with curriculum and assessment mandates.

Findings from our pilot work with the Web-based assessment were encouraging. Small groups of students from seven schools (three middle schools and four high schools) completed the Environmental Awareness task. References to underlying causal relationships within the pictured environment were more common in the descriptions provided by students from schools that contribute large amounts of Atmosphere data to GLOBE. When asked specifically to focus their description on the water cycle, students from these same classrooms made reference to a larger number of the key ideas underlying the water cycle. Thirty-two small student groups, from the six schools that had contributed extensive Atmosphere data, also completed the Olympic task. Although we did not have the opportunity to contrast students from classrooms implementing GLOBE to different degrees for this task, we were able to contrast the performance of high school and middle school students. High school students provided more data graphs to support their site selections and were more likely to present data and arguments consistent with each other. Seventy-four percent of the higher schoolers' graphs supported the argument in their text, compared with 40% of the graphs provided by middle school groups. These data suggest that our task is sensitive to different levels of performance and that relating data to a line of reasoning is not a trivial issue at the middle school level.

Unlike most programs attempting to introduce new instructional materials or to influence the way teachers teach science, GLOBE has a built-in measure of project activity—submissions to the GLOBE Student Data Archive. (GLOBE is more than data submission, and we know from prior teacher surveys that many teachers will introduce some of the GLOBE learning activities or use GLOBE data collection protocols informally without submitting the data through the Internet. Nevertheless, those teachers who do submit data provide a convenient index of project participation over time.)

Because the structure of the GLOBE data-reporting forms and the number of separate pieces of data that schools must fill in to submit them have changed markedly over the program's history, SRI chose to analyze the number of schools reporting data (rather than the number of separate pieces of data reported) as the measure of GLOBE activity over time. Roughly 1,000 schools submit GLOBE data to the Data Archive during each month of the Northern Hemisphere's typical academic year. (Smaller numbers of schools submit data in June, July, and August.) Despite the fact that more than 2,000 new teachers were trained in GLOBE in both 1997-98 and 1998-99, the number of schools reporting data has remained steady over the past 2 years. Looking within specific investigations, the more widely implemented protocols within the Atmosphere and Hydrology investigations were implemented by roughly the same numbers of schools in Years 3 and 4. The Hydrology participation rates in both these years were below those of Year 2, however. The less widely implemented protocols in Land Cover/Biology and Soil have seen some increases, but participation rates are still fewer than 100 schools per year.

Emerging Issues

One of the strengths of the GLOBE Program has been its flexibility and orientation toward reflection and improvement—evolving to enhance the quality of both its scientific and its educational contributions.

Taking a broad perspective, it is clear that GLOBE's partnership model is working. Scores of organizations worldwide are now involved in training and supporting teachers' and students' GLOBE activities. The evaluation data do suggest several areas for further analysis and fine-tuning.

- **Assessing the trade-off between investments in training and investments in follow-up activities.** GLOBE programs face a set of trade-offs as they make decisions about where to invest their energies and resources. To increase the number of classrooms in which GLOBE is implemented, GLOBE partners can either try to bring as many new teachers as possible into the training pipeline or invest in follow-up activities and supports to maximize the likelihood that those who have been trained will actually implement the program. Our Partner Survey data, when viewed in the context of data from other federally sponsored science and technology teacher enhancement programs, suggest that GLOBE partners already do considerably more than average in terms of providing follow-up support. Through the analysis of the specific support factors most effective in producing and sustaining teacher involvement, the GLOBE Program can provide partners with information that will help them make trade-offs and refine their practices. As more U.S. franchises establish a track record of trained teachers, the SRI evaluation team will address this need. In addition, investment in evaluations at the individual partner level (as is already done by some of the international partners and a few franchises) can provide data for individual programs' use in making decisions concerning the settings in which GLOBE is most likely to flourish and the kinds of support and follow-up their teachers need most.
- **Strengthening the involvement of school administrators in supporting GLOBE programs.** It has become increasingly clear that school administrator support (from principals, department chairs, and potentially district curriculum specialists) is important in sustaining GLOBE programs within schools. Administrators control the resources (time allocations and professional development funds) needed to support an innovative program such as GLOBE. These resources are vital not only to individual GLOBE teachers but to groups of teachers trying to form a learning community in support of GLOBE activities. Further, when a school's GLOBE program is challenged by the loss of a GLOBE teacher, administrative support for enlisting and training a new teacher is critical. Involving principals more directly in GLOBE training, extracting more concrete commitments of the ways in which they will support teachers after GLOBE training (e.g., the agreement to provide an aide or supported time for planning GLOBE activities, etc.), and developing channels for ongoing communication with principals are some of the strategies franchises might consider for maximizing the likelihood that the teachers they train will have the resources to mount and sustain an effective GLOBE program.
- **Providing examples of articulated, developmentally appropriate GLOBE implementations.** The GLOBE Program offers an infrastructure, including a scientific database, information and instructional resources, and training, but leaves the specifics of implementation up to individual schools and classrooms. The virtue of this strategy is flexibility. GLOBE has been implemented not only around the world but in grades from kindergarten through early college and in

settings as varied as urban private schools, residential schools for the visually impaired, science museums, and juvenile halls. There is a potential downside to such adaptability, however. GLOBE offers an extensive array of resources but leaves to the individual teacher the task of determining how to coordinate GLOBE components with each other and with local and state curricula to build a coherent educational experience. The magnitude of this effort should not be underestimated.

For the next edition of the Teacher's Guide, we recommend review and revision by an experienced team of science educators, including one or more with developmental psychology expertise, to build recommended GLOBE sequences of activities and protocols that fit together conceptually and build in developmental stages that can be used at different levels of schooling. These sequences, of course, would be suggestions rather than mandatory combinations. Nevertheless, they would provide a starting place for building a coherent program, and would help teachers, schools, and districts make intelligent choices about how to implement GLOBE.

- **Helping current and prospective U.S. GLOBE teachers deal with pressure from external accountability systems.** The GLOBE Program is sensitive to teachers' needs to justify devoting time to GLOBE activities within the context of state and local curricula. Although GLOBE itself does not deal with curriculum standards, it has encouraged franchises to relate GLOBE activities to state and local curriculum frameworks and to share this information with the teachers they recruit and train. Comments from GLOBE teachers interviewed in the field suggests that relating GLOBE to curriculum standards and frameworks alone will not be sufficient, however. The greatest pressure is associated with broad-scale assessments, particularly those with accountability consequences (such as teacher pay, school takeover, or even job loss). An examination of some of the more widely administered tests for consistency with GLOBE content would prove helpful to many GLOBE franchises.

  We are not suggesting that GLOBE be modified to fit the content of statewide assessments but rather that those areas of overlap, where state and district assessments are tapping skill areas emphasized in GLOBE, be well understood and communicated.

  Articulation of these areas of overlap would help teachers see how GLOBE can be an alternative approach to teaching skills and content for which they are being held responsible. In addition, this articulation could make the GLOBE materials more teacher friendly. For example, highlighting the mathematics concepts and skills used in each of the GLOBE protocols and related activities would help teachers judge the applicability of those materials for their students. Teachers would know what mathematical concepts and skills can be practiced through the protocols and would be able to judge their students' readiness for these activities.

- **Continuing to strengthen student involvement in all phases of science investigation**. For several years now, GLOBE has been trying to provide students with involvement in science inquiry that extends beyond the process of collecting and recording data. It has become clear that, at present, GLOBE is very dependent on the inclination and skill of the individual teacher in providing these experiences. The GLOBE Program has proceeded on multiple fronts to support teachers in providing this meaningful context. The 2000 Teacher's Guide will have an increased emphasis on data analysis and interpretation and on communicating findings. In addition, the GLOBE Program is now recommending that 25% of the time spent on teacher training be devoted to helping teachers learn how to support their students in planning, executing, analyzing, and communicating research investigations. Features added to the GLOBE Web site in recent years, such as the graphing capability and the Student Investigations journal, give students tools for using GLOBE data in their own investigations and for reporting those investigations to a wider audience. This aspect of the Web site could be further enhanced by adding a section where students can collaborate during the phases of posing scientific questions and puzzling through approaches to addressing them. An on-line student discussion group or joint lab notebook (structured as a hypermedia database) could be added to the current School To School Page, which allows school to sign up for joint investigations with other GLOBE schools.

Another implication of the increased emphasis on involving students in data analysis and interpretation is the need to examine the usability of the interface to the data archive. We would recommend research on how students and teachers are using the GLOBE Web site, the features they find most helpful, and the difficulties they encounter in trying to use the data for their own analyses.

Summary

In summary, GLOBE appears to be at a new stage in its evolution. GLOBE is both becoming more widespread internationally and successfully transitioning to a “franchise” strategy within the United States. It now seems clear that there are numerous organizations within the United States interested in recruiting, training, and supporting GLOBE teachers, and that a significant number of these organizations are capable of marshalling the resources needed for these activities. The challenge for GLOBE today is to provide even better support for high-quality classroom implementations.

The franchise training model is taking off in terms of number of teachers trained, and survey responses suggest that many of the programs are exemplary in terms of provision of a large number of supports for newly trained teachers. These efforts need to continue, with franchises sharing effective strategies and continuing to add to their support efforts.

At the program level, we recommend support for improving the coherence of GLOBE offerings and consistency with learning goals emphasized in state curriculum standards and accountability systems. Further, GLOBE is committed to supporting teachers’ efforts to involve their students in all phases of scientific investigation. Strategies for providing supports include enhancements to the GLOBE Web site, new Teacher’s Guide materials, and a reorientation of a significant portion of teacher training.

Chapter 1. Introduction

Global Learning and Observations to Benefit the Environment (GLOBE) is an international science and education program, first announced on Earth Day in 1994. GLOBE involves elementary and secondary school students from around the world in measuring the characteristics of their local atmosphere, water bodies, soil, and vegetation. GLOBE students are involved in authentic science investigations, led by GLOBE scientists who have designed the data collection protocols and review and analyze the student data. Since the start of GLOBE data collection on Earth Day 1995, GLOBE students have used data entry forms on the World Wide Web to submit their measurements to a central archive, where they are combined with data from other schools. Students can access the full GLOBE data archive and visualizations based on GLOBE data and relevant reference data sets.

Through these activities, GLOBE seeks to fulfill a three-part mission:

- to enhance the environmental awareness of individuals worldwide,
- to increase scientific understanding of the Earth, and
- to improve achievement in science and mathematics education.

By June 1999, teachers from over 7,500 schools in 84 countries had participated in GLOBE. Of these schools, some 5,000 were in the United States and roughly 1,900 in other countries. Worldwide, nearly 11,000 teachers have been trained to implement GLOBE (more than 8,000 in the United States and more than 2,500 from other countries).

GLOBE provides a scientific framework and educational resources; it is neither a curriculum nor a fully specified educational intervention. Other than requiring careful adherence to the data collection protocols, GLOBE gives schools complete latitude in determining the (K-12) grade levels and classes in which to implement the program, the educational activities to provide, and the way in which the program will be integrated with the local curriculum.

Program Evolution

During the program's first year of operation, as programs were being set up in non-U.S. GLOBE partner countries, teachers were recruited in the United States through a *Federal Register* notice inviting U.S. schools to apply to become GLOBE participants. Schools applying to join GLOBE had to commit to the schedule of data collection (which included weekends and school vacations) and to participation for a 3-year period.

By March 1995, the 400-page First Edition of the GLOBE Teacher's Guide was ready and GLOBE began training teachers. Training sessions were hosted by NASA's Space Grant programs at roughly a dozen university sites across the United States. Training was conducted by teams composed of a facilitator plus two scientists, two technology specialists, and two educators working under contract. Training sessions were planned for 3 days, with an optional fourth practice and refresher day, and included discussion and conduct of each of the data collection protocols, a limited number of educational activities, and practice with the Internet and with using software for manipulating satellite images. Given the wealth of material to be covered, evening as well as daytime training activities were conducted. Training sessions began in March 1995 and continued throughout the year. More than 1,500 teachers received GLOBE training during 1995. Typically, each school sent one teacher for GLOBE training.

Notwithstanding the enthusiasm of the early GLOBE teachers and the data contributions made by their schools, the GLOBE leadership soon realized that their approach imposed limitations on the program's size. GLOBE enjoys support from five federal agencies but does not expect to see major increases in its funding level. At a cost of roughly $1,000 to train a GLOBE teacher, the program would soon run out of funds to provide for all the teachers interested in participating. Moreover, GLOBE teachers were confronting multiple challenges as they worked to get the program up and running at their schools. In some cases, expected equipment or Internet connections were not in place. In other cases, teachers had trouble fitting GLOBE into the curriculum they were expected to cover in their particular course. Sometimes, getting students to a study site or providing supervision for students conducting activities in two different locations was an issue. Moreover, the GLOBE Program realized that the small number of individuals providing GLOBE training could not possibly provide ongoing advice, encouragement, and assistance to all the GLOBE teachers being trained across the United States.

Franchise Training

To address these challenges, a new teacher training strategy was developed for the United States. Under this "franchise" model, the GLOBE Program enters into a no-exchange-of-funds partnership with a university, school district, science center, or other nonprofit entity interested in providing GLOBE training in its service area. The franchise partner sends those individuals who will be providing training for teachers to a GLOBE train-the-trainer workshop and receives GLOBE materials (Teacher's Guides) for distribution to the teachers it trains. Thus, franchise partners perform many of the same functions within their regions of the United States that GLOBE international partners do elsewhere in the world. Franchises leverage the federal investment in the program's scientific, technical, and educational infrastructure but are responsible for paying their own operating costs. The first U.S. franchise partnership agreement was signed with Drexel University in 1996. By June 1999, GLOBE had entered into 95 partnerships with U.S. institutions interested in providing GLOBE training.

By school year 1998-99, 76% of the teachers receiving GLOBE training in the United States received their training from a GLOBE franchise. Although contract training sessions continue in selected sites across the United States, they are fewer in number than in the early years of the program.

The rising importance of GLOBE franchises introduces a major degree of variability into the program, by design. GLOBE franchises are free to determine what groups they want to target in their recruitment and how to interest those groups in the program, how to schedule training, and what supports and incentives to offer teachers. Part of the franchise philosophy is to allow for local flexibility and program tailoring to meet the needs of a particular locale, local curriculum, and preferred instructional approaches. GLOBE anticipated also that franchises would be able to provide greater ongoing support to teachers implementing GLOBE in their own geographic regions. This report documents the wide variation in franchise practices and attempts to provide an early assessment of the extent to which the franchise strategy is providing the intended benefits. To the extent data are available, we have also related variations in franchise practices to variations in program outcomes. Although franchises differ from each other on many dimensions, we have sought patterns across all the franchises training significant numbers of teachers so that we can discern effective strategies that other franchises may want to consider.

International Partners

The increasing importance of franchise training providers is one of the most obvious changes in the GLOBE Program over the course of its first 4 years, but a concurrent increase in the number of active international programs is significant, also. In 1998-99, the number of teachers trained by international partners, at 997, was roughly double the number of teachers trained in 1997-98. International partners have the same kind of latitude as U.S. franchises to determine what schools and teachers to involve and how to structure their training and support. In addition, international partners may be represented by different types of organizations (e.g., an education ministry in some countries, an environmental ministry or a nongovernment organization in others) and are working within a broad range of different education systems. International partners also contribute their own perspectives regarding the greatest potential contribution of GLOBE and adapt the program to their own cultures and priorities. As GLOBE participation becomes more international in scope, non-U.S. programs demonstrate the flexibility inherent in GLOBE and the number of different implementation approaches that can thrive in different settings.

Increased Offerings

Two other trends are quickly apparent to observers contrasting GLOBE in 1999 to GLOBE in 1995. The program now offers many more data collection protocols and learning activities (27 and 41, respectively) than were available when the program was first launched in schools. Moreover, a second wave of GLOBE scientists (selected through a second National Science Foundation peer review process in 1997) is currently involved in developing additional protocols and learning activities for inclusion in a new edition of the Teacher's Guide to be released in 2000.

As the amount of GLOBE material has increased, it has become increasingly difficult for any one class or teacher to productively use all of this material. In addition to the sheer number of data collections and learning activities, GLOBE includes many other functions and components. Students can learn much by exploring the GLOBE Web site; they can analyze existing data in the Student Data Archive; they can exchange GLOBEMail with other GLOBE schools, develop joint research projects, and submit their reports and findings for inclusion in the on-line Student Investigations journal. Activities involving use of MultiSpec software to manipulate satellite images are another open-ended aspect of the program. Few teachers can handle all of these components single-handed.

Learning Communities

Since its second year of operation, the GLOBE Program has encouraged multiple teachers from a single site (either a school or nearby schools or other organizations) to band together and implement GLOBE as a "learning community." By spreading responsibility and offering mutual support, such communities can offer richer and more sustainable program implementations. U.S. schools with multiple GLOBE-trained teachers are more than twice as likely as those with a single teacher to contribute data to the GLOBE data archive. This trend reinforces and is reinforced by the trend toward franchise training, since it is often more economical to send multiple teachers to training that is offered by a nearby organization. At the same time, the program's view of successful implementation has shifted from one emphasizing the involvement of as many schools as possible to one emphasizing rich implementation of multiple components of GLOBE over an extended period of time.

Overview of the Report

This report focuses on issues raised by the program's evolution. Chapter 2 describes the methods used in our data collection. Chapter 3 provides a snapshot of GLOBE activities in two classrooms, one in downtown Los Angeles and one in a small town in Alabama. Chapter 4 provides data on the growth of the program in terms of number of teachers trained, amount and diversity of data reported, and consistency of data reporting over time. The chapter also describes the increasing proportion of trainees and data-reporting schools that have been recruited and trained by GLOBE partners, both internationally and within the United States.

Chapter 5 presents and discusses findings from a spring 1999 survey of GLOBE partner coordinators, both U.S. and international. The survey discussion focuses on the recruiting, training, support, and follow-up practices of GLOBE partners within the United States and abroad. An analysis relating these practices to the data-reporting practices of the schools trained by the U.S. partners is presented, also. Chapter 6 presents descriptions of several selected franchise programs. Chapter 7 provides an account of how GLOBE international partners view the program, the challenges they face, and the strategies they are using. Chapter 8 describes our ongoing research and development of

Web-based assessments for evaluation purposes. Chapter 9 offers a discussion of issues facing the GLOBE Program as it matures and attempts to both sustain existing communities and reach a wider audience of students and teachers with new teacher materials, protocols, and learning activities for the year 2000.

Chapter 2. Overview of Evaluation Methodology

This report focuses on evaluation activities and findings from 1998-99, the fourth school year of GLOBE implementation. In this chapter, we provide an overview of the data sources and methodology applied in our Year 4 evaluation activities.

The five main sources of information used—the database developed by GLOBE, SRI's Partner Survey, country coordinator interviews, franchise case studies, and Web-based assessments—are described below.

GLOBE Database

NOAA maintains the GLOBE Student Data Archive, to which students submit their measurements. The data archive contains the name and location information for the school submitting the data, the type of data, the date on which the data were collected, and the specific readings. Information formerly maintained in a separate master database of "registered" U.S. GLOBE schools is now a part of the GLOBE Student Data Archive. This section of the database tracks contact information for schools, teachers, and principals, as well as information about GLOBE teacher training. In this archive, GLOBE data are associated with the students' school but are not linked to a particular teacher. Although practical from the standpoint of analyzing environmental data by site, this arrangement precludes certain types of analysis (e.g., relating teacher characteristics to data reporting) that would be useful for evaluation purposes. Statistics from the database have been used in the analysis for Chapter 4 of this report, describing the growth of the program in terms of the number of schools reporting data, number of teachers trained, and frequencies and types of data reported. We have also used the data archive to examine the proportion of schools for which a franchise has trained teachers who are reporting data.

Partner Survey

GLOBE partner country coordinators and U.S. franchise coordinators were surveyed in the spring of 1999. Our sample for the Partner Survey was the existing universe of active partners and franchises as of March 1999. The survey and a cover letter explaining its purpose were mailed to all the country coordinators of GLOBE partner countries and all coordinators of U.S. GLOBE partner franchises on March 30, 1999. On April 20, nonrespondents were sent reminder postcards. On May 11, a letter from Tom Pyke, the GLOBE Director, urged remaining U.S. nonrespondents to send in their surveys. A similar letter from Barbara Means, principal investigator for SRI's evaluation, was mailed to international country coordinators on the same date. Late in May and early in June, reminder e-mails were sent by GLOBE Assistant Director for International Programs Lyn Wigbels to nonresponding country coordinators and by GLOBE Deputy Director Margaret Finarelli to nonresponding U.S. franchises. Subsequent e-mail follow-ups were made by both GLOBE and SRI staff. On June 15, data collection was stopped and instruments received were processed for analysis.

Appendix A contains a copy of the Partner Survey used in this data collection.

Table 2.1
GLOBE Partner and U.S. Franchise Populations and Sample Sizes

	Population	*Respondents*	*Response Rate (Percent)*
U.S. franchises	77	52	68
International partners	84	45	54
Total	161	97	60

Country Coordinator Interviews

Country coordinator responses to the Partner Survey were supplemented with information gained from face-to-face interviews conducted with selected coordinators attending annual GLOBE conferences in the United States. Selected coordinators (primarily those in countries with active programs) have been interviewed by SRI researchers in the summer of 1997, 1998, and 1999. Information provided by these coordinators has been used to provide specific examples of international GLOBE Program practices, adding descriptive detail to the quantitative data gained from the survey. Information provided by the country coordinators in these interviews and in response to open-ended survey items is discussed in Chapter 7.

Case Studies

Our research plan included site visits to four U.S. franchises, where we observed teacher training and the GLOBE activities of previously trained teachers. Sites were chosen that represented different franchise training models.

In selecting case study sites, we wanted to limit our sample to those franchises that had been active enough to have a critical mass of trained teachers and data-reporting schools. We identified those U.S. franchises that had trained 50 or more teachers and had at least 5 schools reporting GLOBE data by the fall of 1998. We acknowledge that data entry is not the only evidence for the effects of franchise teacher training, but it is an important indicator for GLOBE and ensures that the case study franchise programs have reached some level of maturity.

We also wanted different sites to represent the different types of institutional “homes” of franchises—school districts, universities, and cross-agency programs, for example. A franchise’s approach to teacher training and support may differ from the approaches of others, depending on the nature of the mission of its home organization and its supporting infrastructure.

An additional consideration in site selection was the timing of franchise training. Several potential case study sites were eliminated because they did not have any training sessions scheduled between December 1998 and April 1999.

After conducting on-site observations and interviews at the four case study sites, researchers prepared “debriefing forms” describing each franchise’s practices in a standard format. These debriefing forms were then analyzed to identify compelling examples and cross-cutting trends.

Development and Piloting of On-line Student Assessment

In the Web-based assessment environment, we aimed to provide a set of problems that would require students to use the concepts they encounter in collecting and analyzing GLOBE data. We anticipated that greater exposure to GLOBE would contribute to a better understanding of the environment as an ecological whole and to more effective skill in using data to reason and make decisions about a real-world problem. Building on our pilot measure of student environmental awareness conducted in Year 3, we set out to design an on-line measure of environmental awareness. This assessment was complemented by a second task calling on two other skills that students may develop through participation in GLOBE activities—data analysis and problem solving.

The assessment environment was created with a number of design components in mind. First, we wanted to be able to construct a measure that would assess the cognitive benefits of participation in GLOBE. To that end, we aimed to create a task that was well aligned with GLOBE protocols and learning activities and that measured students' data analysis skill in a problem-solving context. We also needed to create an environment that was accessible to remote users, where no researchers would be present. In this way, we could ensure wide geographic representation in our sample and create an efficient means for measuring student learning that could be scaled up in future years. We aimed to create a measure aligned with geography and science standards that measured students' awareness of "big ideas" of environmental science, such as adaptation and ecosystems.

In the on-line assessment environment, students perform two sets of tasks. First, they describe features of the environment they see in a color image of the Mount Hood (Oregon) region. Second, students are asked to solve a real-world problem involving the use of climate data, including air temperature and precipitation, and to present an argument justifying their solution to the problem.

The first set of tasks is aimed at measuring students' environmental awareness, defined as an understanding of how global processes interact to form a dynamic system whose workings are visible to students at both the global and local levels.

In the second set of tasks, students are asked to demonstrate their skill in data analysis and problem solving. Students are told that they must decide whether Salt Lake City is in fact the best choice among five cities for the 2002 Winter Olympics, based on climate data provided to them and a set of constraints set forth by the Olympic Committee. Students select the city they believe would be the best choice and develop an on-line presentation to the Olympic Committee that describes why their city is the best choice and includes graphs that the students generate on-line to compare their city with Salt Lake City's data on a given parameter.

We administered our pilot assessment tasks within samples of schools chosen on the basis of their reporting levels for Atmosphere data. We examined the GLOBE database and identified a random sample of 20 middle and high schools across the United States that had made more than one standard deviation above the average number of air temperature and rain precipitation measurements between September 1998 and March

1999. We then identified a sample of 20 middle and high schools that were part of the GLOBE Program but that had reported only one or two Atmosphere measurements during that same time period. We wanted to compare such "high" and "low" GLOBE implementers within our pilot study, because this design minimizes what researchers call "selection bias." Teachers who become involved in GLOBE may obtain different outcomes from their students than teachers who do not become involved, not because of the specific merits of the program itself but simply because they are more innovative teachers. By comparing active GLOBE classrooms with classrooms that are involved in GLOBE but devoting less time to it, we can better measure the specific effects of participation in the GLOBE Program.

Schools in these two groups of 20 were recruited for participation in the pilot study. Some schools were unable to participate, either because of lack of the necessary equipment and connectivity or because of schedule conflicts. Our final pilot sample consisted of 6 high-implementing schools (2 middle schools and 4 high schools for the Olympic task) and 1 low-implementing middle school for the Environmental Awareness task.

Future Data Collection Activities

In the spring of 2000, two samples of GLOBE teachers will be surveyed: those linked to schools reporting data consistently and a random sample of the population of trained teachers from schools that have not reported data. Web-based assessments also will be conducted with middle and high school students. Site visits and interviews with teachers, students, administrators, and GLOBE scientists and partners also will be conducted.

Chapter 3. GLOBE in the Classroom

Before turning to the quantitative data that will reveal changes and practices within the GLOBE Program, we devote this chapter to descriptive data collected at the classroom level. In analyzing program growth over time and the factors related to stronger implementations, we have used the best available quantitative measures—frequency and types of data submitted to the GLOBE data archive by schools with GLOBE teachers. GLOBE is much more than data reporting, however. In its entirety, it is an opportunity for students to be part of an authentic science investigation, to experience the rigors and challenges of taking scientific measurements, and to become intimately involved in the process of making meaning out of scientific data. In this chapter, we attempt to convey something of the richness and variety in GLOBE-related activities as they unfold at the classroom level. We provide qualitative descriptions of activities within two classrooms visited in conjunction with our site visits to GLOBE franchises. These classroom vignettes illustrate the fact that GLOBE is a set of resources and an overarching suite of scientific investigations; it is neither a set curriculum nor a highly specified pedagogy. The teachers we describe work in elementary schools in two very different settings—one urban and one rural—and use GLOBE to further two quite different sets of instructional goals.

Using GLOBE to Promote Deep Understanding: Los Angeles, California

John Fosse, a science teacher at 122nd Street Elementary School, was trained by the Los Angeles Unified School District franchise in 1998. During his interview, Fosse mentioned that the instruction provided at the training was the "best he had ever had" because, among other things, it provided him with a chance to become a learner and to further his understanding of how his students feel about learning science in his own classroom. The following excerpt was taken from his interview:

> *"They have allowed us in our training to be the students, to actually learn, to put ourselves in the chair of the students. Two reasons: to learn the protocols for the other activities and the information that goes with it, and to feel what it is to be that learner. I think it helps you to connect with the child, the student. You relate to what they are going through because you went through it. You may have gone through on another level, on a level that challenges you and then you break it down and then make it meaningful to the student. Training… most of the training*

we received at UCLA. Individuals were there for us from all different grade levels through and including high school. There was a number of UCLA faculty that would provide us with overview and information on a very adult level for our understanding. Then we'd break that down into teachable segments so the students can assimilate it and try to make their own actions."

Fosse's experience with the GLOBE training affected the way he, in turn, trains others. Fosse drew on his GLOBE training experience in designing in-service teacher professional development for other teachers at his school. Specifically, Fosse and another teacher have been conducting in-service programs for teachers who need science exposure at their school. The programs that they have created are focused on students, parents, and teachers working collaboratively on science projects. They refer to one of these events as "Science Night"—a night when teachers, parents, and their students are invited to their school for an evening of science learning. The event is specifically aimed at teachers and parents who "need additional science exposure," and it is a chance for them to learn with their own students and children.

The inquiry-oriented collaborative learning approach that Fosse adopted for his own teaching is also evident in the way he incorporates GLOBE protocols into his curriculum. Fosse wants his second-grade students to recognize and understand changes in their environment. For example, in his interview, John stated that "Our world is ever changing…three days ago we had an 82-84 degree day…yesterday it became terribly overcast…and we had a chance to recognize that Southern California doesn't have a lot of clouds. … But we were going to predict whether or not it was going to rain, and we predicted that it wasn't because they've seen that pattern before. And it didn't."

Recognizing change and understanding interrelationships among the factors producing these changes are critical if students are going to be able to grasp many of the key concepts in environmental science (e.g., adaptation, interdependence, ecosystems, cycles). To achieve in science, students need to acquire complex knowledge structures within which science concepts are interrelated, as opposed to lists of discrete, factual pieces of knowledge (Brown, 1992; Chi, Glaser, & Farr, 1988, Glaser, 1991; Shavelson & Ruiz-Primo, 1998). GLOBE provides Fosse with a context for involving students in the systematic collection of data and in data analysis and interpretation.

On the day of our site visit to Fosse's classroom, his students were on their third day of exploring temperatures of air and soil. Fosse wanted his students to be able to develop predictions and explanations about the temperature inside a room relative to that outdoors. After many of his students had successfully completed their calculations and compared their temperatures, they found that the temperature outside was colder than the temperature inside. He then asked the students to consider soil and predict whether the soil would be warmer or colder than the outdoor air temperature.

Students worked collaboratively in groups of three or four, taking several measurements of the air and then thinking about their soil predictions. During his interview, Fosse stated that he prefers to have his students estimate or make predictions on their own before they use the temperature probes because it forces them to take a little risk—to try to figure out what they think and to see whether their estimate falls within the range of reality.

As one group of students began conducting their analyses, one of the students explained to the other students that he knew why the temperature of the soil would be colder than the air. He reasoned "…because when it rains the soil has the water in it and the water is colder, so the soil must be colder." The other students accepted his prediction, and after placing the soil temperature probe into the ground, the students crouched over it to check the soil temperature gauge and to see whether his prediction was correct.

The student who made the prediction pointed to the temperature gauge and said, "See, the arrow is pointing to there [points to gauge], so it is a colder temperature." But when he pointed to the gauge and read the values, it was apparent that his prediction was wrong. The soil temperature reading was higher (i.e., warmer) than their previous air temperature readings, and he had misread the gauge. Unfortunately, the other students didn't realize his error because they were also having difficulty comparing temperatures that were depicted across two different types of gauges and were distracted by the challenge of translating between two different representations of temperature. (The soil temperature gauge is circular and depicts Celsius and Fahrenheit in a round, clock-type design, indicating a higher temperature by the clockwise movement of the needle. In contrast, the air temperature gauge depicts temperature in Celsius and Fahrenheit in two columns, with the height of the mercury column increasing as temperature rises.) When probed, the students made comments that indicated that they thought (perhaps influenced by the one student's prediction) that a higher reading on the soil temperature gauge meant that it was colder.

Figure 3.1
GLOBE Soil Temperature Gauge in Use at 122nd St. School
(Los Angeles, California)

As the students were grappling with deriving readings from two different temperature gauges, the interviewer asked the student who had made the previous prediction about the soil whether it would make a difference if the soil temperature probe were 10 feet longer. Specifically, the interviewer asked him "whether the temperature of the soil at one end of the probe would be colder or warmer than the temperature of the soil at the top part of the probe." The student thought about this question momentarily and then stated: "Oh, well, it would be warmer at the bottom of the soil probe because it would be closer to the Earth's core, where it is very, very hot."

Figure 3.2
Reading the Air Temperature Gauge

At this point, their teacher, John Fosse, and several other students had gathered around as we walked over to a hole in the school yard previously dug by construction workers hired to fix a main pipe in the school. The interviewer pointed to the hole in the ground and said, “Well, this isn’t 10 feet deep, but why don’t we do a small experiment to test your prediction” about higher temperatures deeper in the ground. The students placed the soil probe in that hole to see whether the temperature would be higher at a greater depth.

The students saw that the temperature of the soil was lower rather than higher at the bottom of the hole, but they quickly explained that the soil temperature was colder in the hole because of the mud that was also found inside the hole. They reasoned that because the soil had absorbed water and become muddy, it wasn’t a good comparison to make because the water would make it colder than most holes. At this point, the interviewer smiled and agreed that answering the question would require further measurements of different holes in the school. The students were pleased with their efforts.

Figure 3.3
Soil Temperature Check

From a cognition and learning perspective, this vignette is revealing in several ways. First, students are learning to use scientific instrumentation through GLOBE. Second, when teachers like John Fosse invite their students to interrelate the different GLOBE measurements and to start making predictions, students can begin developing a deep understanding of some very difficult concepts. Such activities call on students to provide causal accounts or justifications for their claims or predictions. Even though in this example the student's knowledge of the Earth's core interfered with his judgment about relative temperatures at different soil depths, there is evidence to suggest that he was building a mental model about temperature and soil and was using his model to generate coherent explanations. In other words, his beliefs or ideas about soil and temperature were not presented in an "ad hoc" way or as discrete bits of information; rather, his statements about soil were interrelated in a consistent manner, an important quality of scientific explanations. For example, his first prediction (i.e., that the temperature of the surface area soil would be colder than the air) was also consistent with his explanation of the counter evidence that the soil's temperature was in fact lower at the bottom of the hole (in both cases attributing a temperature-lowering property to water). Further experience with repeated air and soil temperatures on both dry and wet days can give the student the counter-evidence that will trigger cognitive growth, as he is spurred to revise his explanation to fit with the data his class has taken.

Using GLOBE to Promote Environmental Awareness: Killen, Alabama

Across the country in rural Alabama, Joan Cox's students are tackling measurement problems in the Hydrology investigation area. Cox is a teacher at Brooks Elementary School, located in Killen, Alabama, a rural community that is growing into a suburb of nearby Florence on the Tennessee River. The school has been implementing GLOBE since 1997, and Brooks' students have been consistent reporters of Atmosphere and Hydrology data to GLOBE ever since. Cox is a veteran teacher and has been involved in environmental education for a number of years. In 1988, she began the school's recycling program, long before the town began to consider the value of reducing and recycling waste. GLOBE was a natural fit, Cox believed, with her own passion for the environment and with her existing curriculum.

She begins each year with a weather unit, which introduces the concepts her third-grade students will need to carry out their GLOBE observations. Cox also occasionally supplements her lessons with learning activities from GLOBE that she adapts to meet her curricular objectives. She notes that now that students are engaged with GLOBE, they are much more aware of climate and that students maintain their interest beyond the first unit of the year. Cox reports that parents have commented to her that their children want to talk about the weather at home, and that they show an unusual interest in the weather segments of the evening and morning news on television.

Initially, Cox has students observe her as she carries out the Atmosphere and Hydrology protocols. Then she teaches the students to take measurements and monitors their accuracy. Once she is assured the students can correctly follow the protocols, she assigns small groups of students to collect and record data for the atmospheric and stream conditions and enter these data on the GLOBE Web site. The students are responsible for these tasks for weeklong periods on a rotating basis. The rest of the students continue with regular classroom activities, and Cox works with them, allowing the students taking GLOBE measurements to work independently.

An interesting feature of the Hydrology study site at Brooks is the presence of a sewage drain near the stream where students take readings. Cox has students take temperature and pH readings in the water just upstream and just downstream from the drain. On the day we observed, students eagerly showed us a new tributary that they had located near the stream site. They demonstrated a keen awareness of their local site, picking up any pieces of trash they found along the stream bank and carefully taking temperature and pH readings at two places in the stream. Cox had students record the readings in a journal, where they also record any interesting observations they make at the weather station and at the Hydrology study site. Students have noticed that temperature is consistently a half-degree warmer just downstream from the sewage drain.

Figure 3.4
Brooks Students Taking Water Temperature and pH Readings

What is particularly interesting about how students at Brooks Elementary implement GLOBE has much to do with their teacher, Joan Cox, and her sensitivity to adapting the activities to the constraints and affordances of the local setting. Students are in fact not just measuring water temperature and pH but monitoring the local environment's waste management system. Students don't have sophisticated equipment (they use pH paper and can't afford a new thermometer that would measure temperature in Celsius),[1] but

[1] The current GLOBE protocol calls for Celsius readings (to avoid errors in converting Fahrenheit to Celsius).

they are engaged in the activity, and their regular readings have engendered a keen sensitivity to their local Atmosphere and Hydrology study sites. The teacher scaffolds this awareness through her own integration of GLOBE into the curriculum and by having the students keep journals, not just of the recorded data but also of any other observations they might have. It's apparent that many of the students are beginning to share Joan Cox's own environmental awareness and skill in observing the local environment.

Discussion

Although a continent apart, the students at Brooks Elementary and 122nd Street Elementary are both experiencing GLOBE as the unifying thread for their science activities. Brooks students are regularly implementing the GLOBE protocols and, at the same time, adding other data collections that help them understand the environmental impact of features of their local study site (e.g., the sewage treatment plant drain). GLOBE is also providing students with the opportunity to take responsibility for their own learning, with rotating teams trading off the data collection and submission duties. In Los Angeles, John Fosse is using GLOBE to help his second-graders develop an understanding of the systems nature of their local environment. As his students make predictions, take measurements, and reflect on their data, they form mental models of the factors coming to play in their environment. Both programs face problems of limited equipment budgets, but find that GLOBE is tremendously motivating and stimulates their students to think more deeply about their environments.

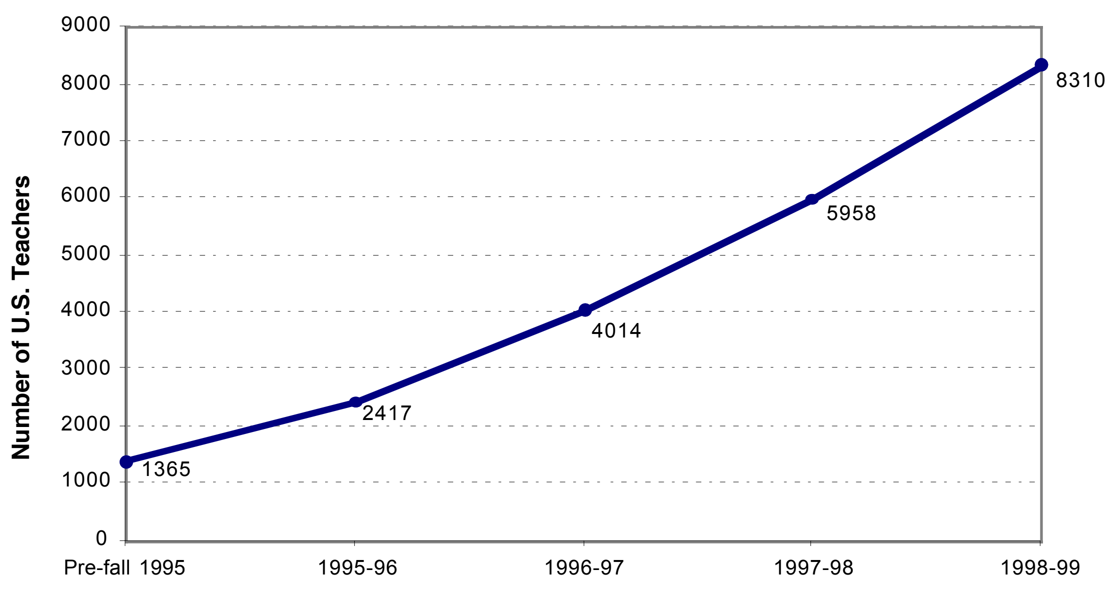
Chapter 4. Program Growth

In its fourth year, the GLOBE Program has continued bringing new teachers and students into the program. This chapter presents quantitative data that capture the program's growth patterns, as reflected in measures such as the number of teachers trained, number of schools reporting data, and number of reports of each type of data submitted each month. Where comparable data are available, comparisons are drawn among Years 1, 2, 3, and 4.[1]

The Number of Teachers Trained

Teacher training is a central activity of the GLOBE Program. Since its first year, 1995, roughly 11,100 teachers have been trained in the United States and internationally, representing more than 7,700 schools around the world. Of these teachers, more than 8,000 were trained in the United States. Figure 4.1 depicts the cumulative growth in the number of U.S. teachers trained since GLOBE began.

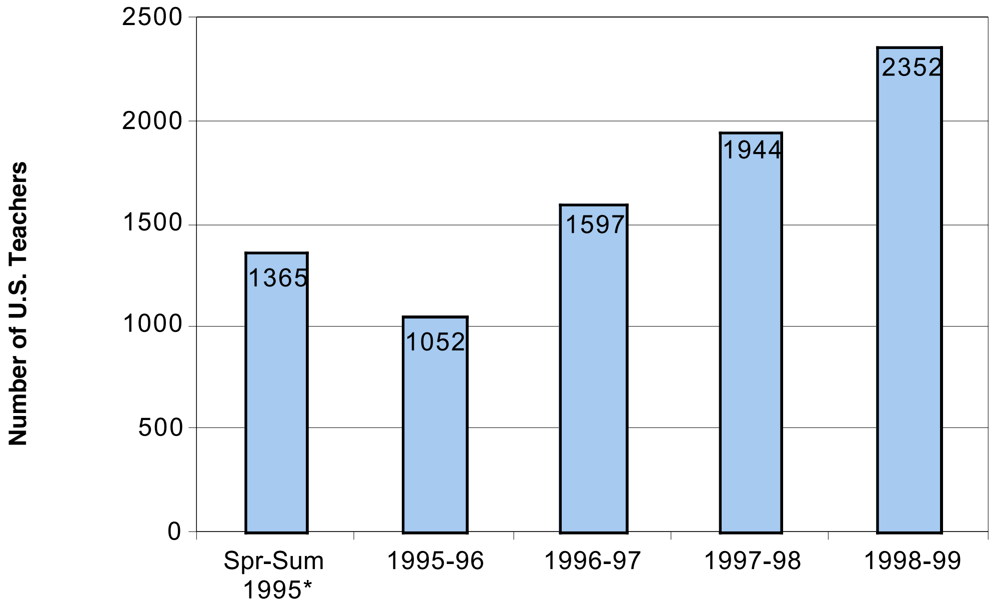
Figure 4.1
Cumulative Growth in Number of U.S. Teachers Trained for GLOBE



[1] Our thanks to Phil Pierce at GLOBE, Len Gallagher at NIST, and Mike Turpin at FSL for their assistance in obtaining the data for these analyses.

Figure 4.2 presents the annual U.S. teacher training statistics from the program's inception through summer 1999. The largest growth in U.S. teacher training occurred during the first 3 years of the program (a rise from 1,052 to 1,944). The number of teachers trained in 1998-99 was higher than that for 1997-98.

Figure 4.2
Number of U.S. Teachers Trained, by Year



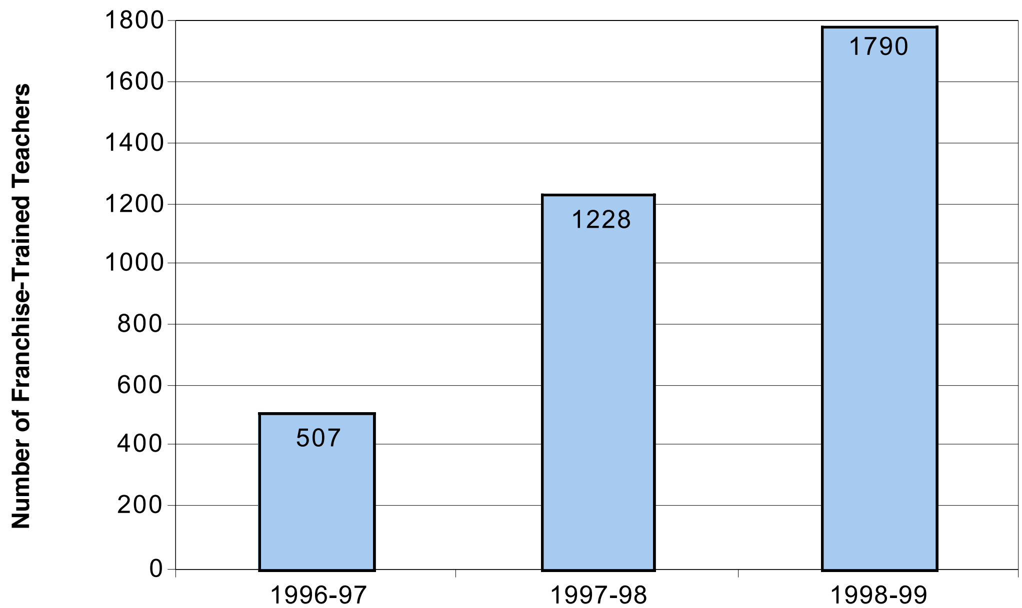
Note: Bars depict 12-month (September-August) training totals except where otherwise noted.

* Teacher training began in spring 1995. A large number of teachers were trained in the program's first 6 months to provide a critical mass of teachers ready to begin the program in school year 1995-96.

The increase in teacher training since 1996-97 reflects the contribution of training by GLOBE "franchises." The rapid assimilation of franchises as a primary training strategy of the GLOBE Program is revealed in Figure 4.3. As of August 1999, memoranda of understanding (MOUs) have been signed with 95 franchises located in 42 states, including Alaska and Hawaii, and also in Puerto Rico. In 1997-98, 76% of the teachers trained in the United States received their training from a franchise; in 1998-99, 63% did so.

Not all franchises are fully operational, however; some are still planning their first training sessions, and others have held one or more trainings but ceased further activity. In 1998-99, 63% of the organizations that have signed franchise agreements actually conducted one or more GLOBE teacher training sessions. Teachers trained by franchises are making an increasing contribution to the GLOBE data archive, but that contribution is not in proportion to their frequency in the trainee population. Of the 798 U.S. schools that submitted their first data since September 1, 1997, 209 (26%) are associated with teachers trained by franchises.

Figure 4.3
Number of Franchise Teachers Trained, by Year

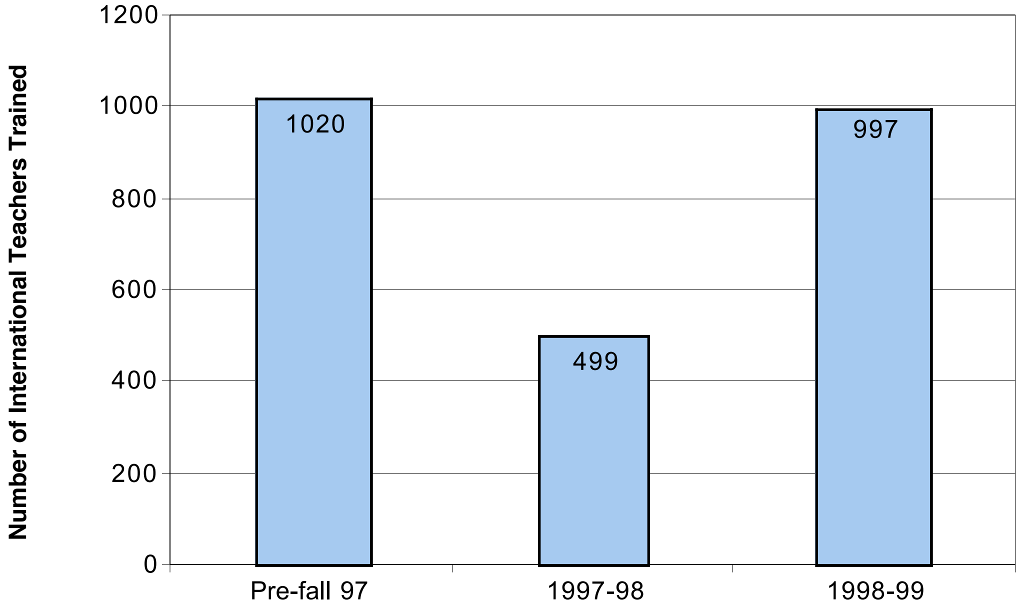


As shown in Figure 4.4, international partners are also a growing source of GLOBE-trained teachers. (Before February 1998, international teachers' date of training was not tracked in the GLOBE master database. Data in Figure 4.4 have been constructed in part on the basis of prior analyses and teacher identification numbers.) Figure 4.4 shows a dramatic increase between Years 3 and 4 in the number of teachers trained by international partners.

Number of Reporting Schools

Schools with GLOBE-trained teachers are monitored to determine the number and proportion of schools that report GLOBE data. Analyses reporting the average amount and types of data contributed by each school are reported monthly by NOAA's Forecast Systems Lab.

Figure 4.4
Number of International Teachers Trained, by Year

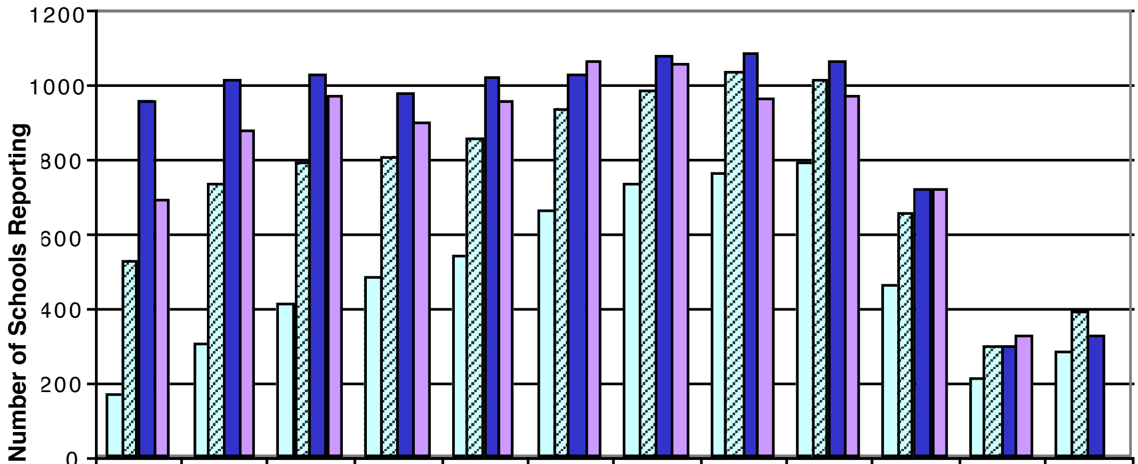


From the program's inception to September 15, 1999, 3,404 U.S. and international schools had reported data. Figure 4.5 depicts the annual trend in the number of schools reporting data each month since 1995-96. About 1,000 schools report data each month during the Northern Hemisphere's school year from September through May. In both 1997-98 and 1998-99, the number of schools reporting monthly was fairly stable, except for the summer months, when there were sharp drops.

Reporting Patterns for Different Data Types

Figure 4.5 shows the number of schools reporting some data each month but does not give any sense of how the individual investigations' data archives are shaping up. GLOBE needs not large numbers of measurements per se, but sufficiently large and consistent data sets for the individual variables or data types included in the various investigations. For each data type, we have assembled the number of reports made by schools on a monthly basis for each of Years 1 through 4. (See Figures 4.6 through 4.11.) Cloud Observations, Air Temperature, Liquid Precipitation, and Solid Precipitation are gathered by many schools on a daily basis and are discussed below.

Figure 4.5
Number of Schools Reporting Data in GLOBE Years 1-4, by Month



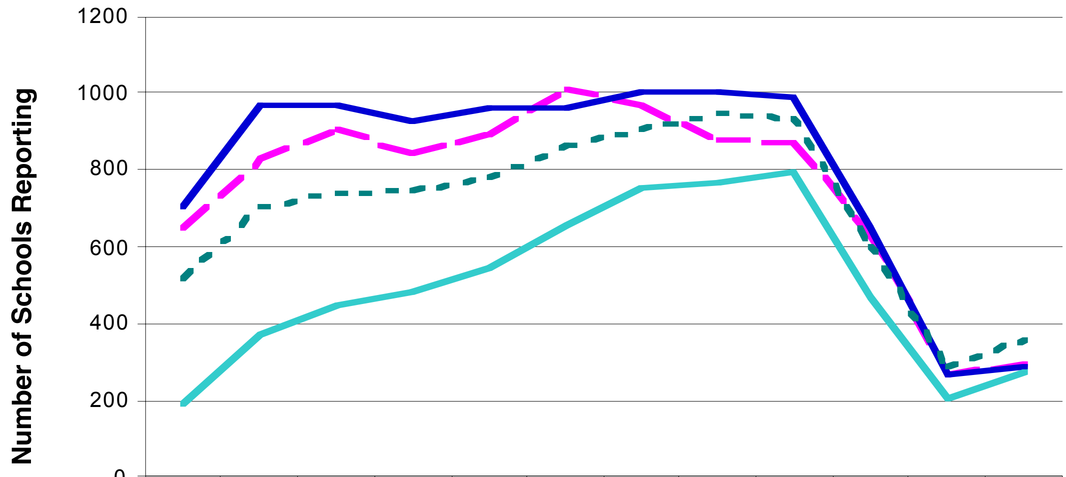
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
95-96	170	308	415	485	543	660	736	763	792	468	210	283
96-97	529	735	793	806	857	936	983	1034	1011	652	304	391
97-98	960	1014	1032	976	1026	1028	1078	1084	1065	720	301	322
98-99	692	882	972	896	961	1071	1060	967	974	721	323	

More Frequent Data Types

Cloud Observations continue to be the most frequently reported data type, though the number of schools reporting this measurement actually was lower in Year 4 than in Year 3, except for a brief spike in February 1999 (see Figure 4.6). The number of schools reporting Air Temperature measurements in 1998-99 was very similar to that reporting in the 1997-98 school year (see Figure 4.7).

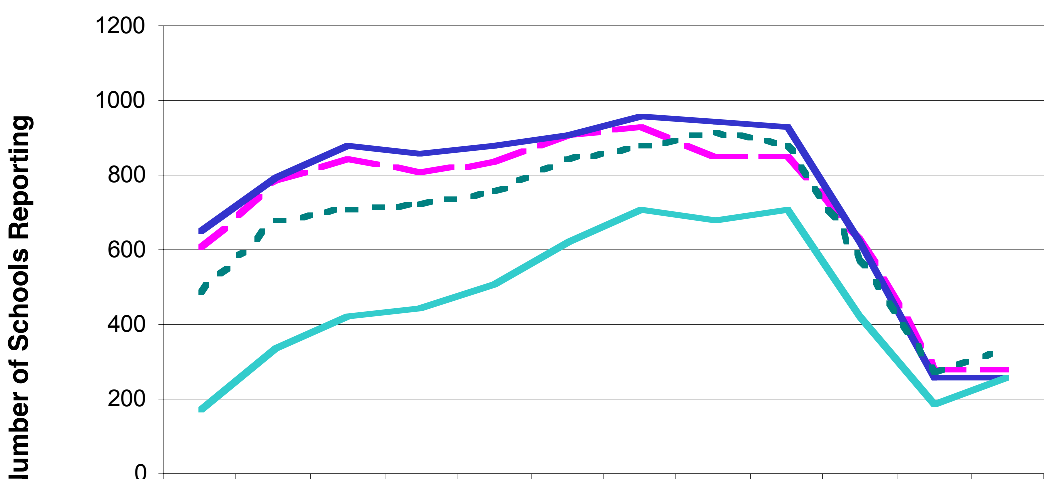
Liquid and Solid Precipitation reporting has grown significantly over rates in previous years, as shown in Figures 4.8 and 4.9. This increase can be attributed to the September 1998 introduction of a combined GLOBE I and II data reporting form requiring the daily precipitation measurements to be filled in before the form can be submitted (i.e., schools can no longer report Air Temperature or Cloud Observations without completing the fields for precipitation). Previously, many schools were reporting Liquid Precipitation measurements but leaving the Solid Precipitation measurements blank when there was no snow to measure. Now, even schools that are located in areas that never receive snow are reporting "zero" or "missing" data in the required field. An analysis of the number of schools reporting daily snow measurements for the period December 1998 through February 1999, compared with the same period in 1997-98, shows that 80% of the 40,375 readings taken in the 1998-99 period were either "zero" or "missing," compared with 63% of the 17,897 readings for the same period in 1997-98. Thus, the dramatic increase in reporting shown in Figure 4.9 reflects a change in the reporting form rather than a true increase in measurement activity.

Figure 4.6
Number of Schools Reporting Cloud Observation Data, by Month and Year



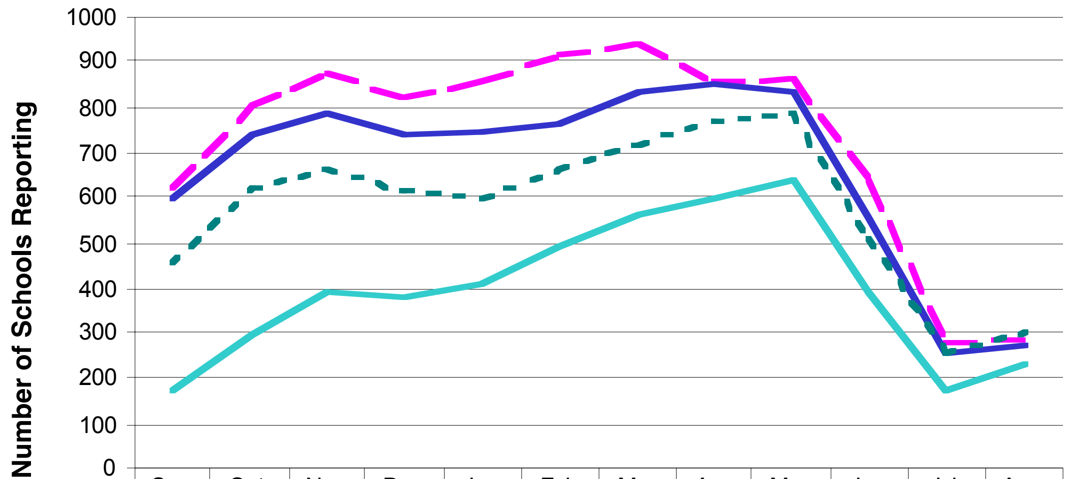
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Cloud 98-99	653	832	905	846	897	1011	969	879	875	632	273	293
Cloud 97-98	709	965	966	930	962	961	1000	1006	988	651	273	288
Cloud 96-97	522	704	743	746	782	862	909	948	934	604	286	358
Cloud 95-96	194	369	449	488	548	658	750	770	799	468	205	274

Figure 4.7
Number of Schools Reporting Air Temperature Data, by Month and Year



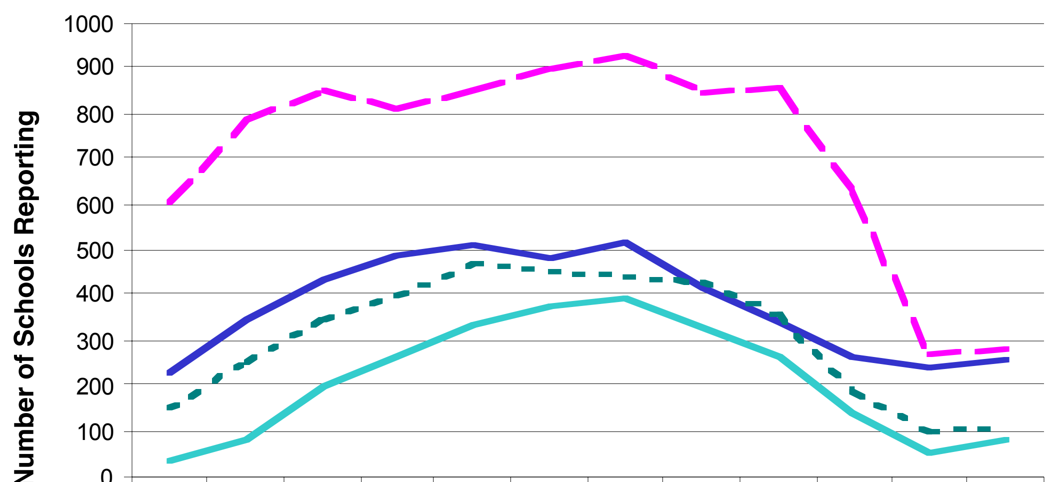
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Air Temp 98-99	606	787	844	808	837	912	928	847	854	633	278	276
Air Temp 97-98	651	798	873	860	880	908	957	942	927	619	257	261
Air Temp 96-97	490	679	713	724	759	843	878	915	883	577	273	340
Air Temp 95-96	176	333	423	443	510	628	713	682	707	426	186	258

Figure 4.8
Number of Schools Reporting Liquid Precipitation Data, by Month and Year



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Rain 98-99	622	802	872	821	854	915	938	855	865	640	282	288
Rain 97-98	601	741	782	737	747	765	833	849	833	561	260	272
Rain 96-97	455	619	663	616	599	663	716	768	785	509	257	307
Rain 95-96	175	300	395	379	410	492	562	597	639	388	174	236

Figure 4.9
Number of Schools Reporting Solid Precipitation Data, by Month and Year

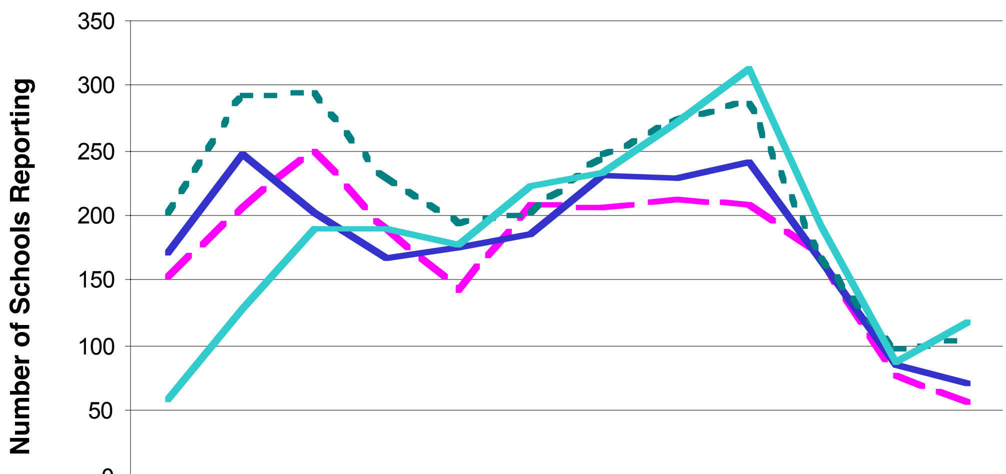


	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Snow 98-99	605	785	850	814	849	899	928	847	857	627	270	282
Snow 97-98	229	344	433	485	510	479	515	415	340	267	237	258
Snow 96-97	149	251	346	396	466	455	437	431	357	189	100	114
Snow 95-96	34	85	197	268	334	376	392	326	263	140	53	79

Figure 4.10 shows the number of schools reporting Hydrology data in Years 1-4. In 1997-98, fewer schools reported Hydrology data than in 1996-97. This decline was attributed to the change in the GLOBE II Hydrology protocols to request monthly

measurements (with weekly measurements as an option), rather than the weekly data reports requested in the original GLOBE protocols. The request for weekly data reporting was reinstituted in the 1997 Teacher's Guide Supplement, which was made available in August 1997. This year's Hydrology data submissions follow a pattern similar to that of 1997-98, with the greatest number of schools (250) reporting in November, a dip in winter, and steady reporting by just over 200 schools from February through May. As in past years, the reporting patterns for Hydrology data are seasonal. Specifically, during September and October, the schools' Hydrology reports increase; during the Northern Hemisphere's winter months, the reports decline; and during spring, Hydrology reports return to the fall levels.

Figure 4.10
Number of Schools Reporting Hydrology Data, by Month and Year



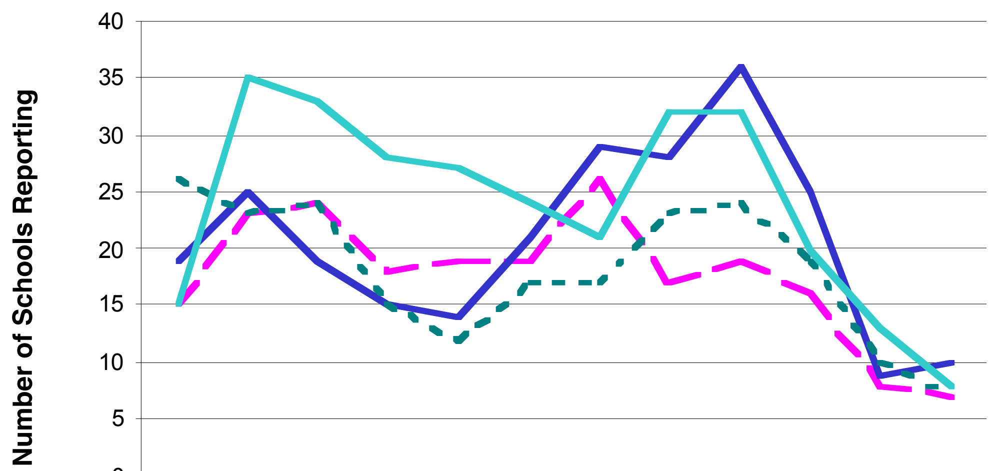
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Hydrology 98-99	154	206	250	190	143	208	206	213	209	169	77	57
Hydrology 97-98	172	247	202	168	176	186	230	229	242	165	86	71
Hydrology 96-97	203	292	293	229	194	203	247	274	286	167	98	106
Hydrology 95-96	59	129	189	189	178	222	234	272	312	193	87	119

The reporting levels are still lower than the peak of almost 300 schools in fall and spring that was attained in the 1996-97 school year. Difficulties locating and consistently visiting a suitable water site and finding the time to perform the measurements remain major barriers for many schools.

Another protocol, Soil Moisture, like Hydrology, was altered in June 1996 to reduce the requested frequency of data collection—in this case, from daily to monthly. This protocol change may have contributed to the reduction in the number of schools reporting data each month between 1995-96 and 1996-97. In the spring of 1997-98, the protocol was simplified, perhaps contributing to the dramatic rise in data collected in the spring of 1998 (see Figure 4.11).

Like those in Hydrology, the data reporting patterns for Soil Moisture measurements are seasonal. Schools report Soil Moisture in the Northern Hemisphere's fall, but there is a drop-off in the winter and a resurgence of data reporting in the spring. Fifty-eight schools reported Soil Moisture data at some point during the 1998-99 school year, with 25 of these reporting for at least five months out of that period. Many of the schools that report Soil Moisture measurements also "batch" their data for entry on a monthly basis, so in comparing the number of schools that reported during a particular month with the number of schools that took measurements, inconsistencies are apparent. Soil Moisture data are reported consistently only by those schools taking daily measurements, suggesting that they have installed the gypsum block measurement system.

Figure 4.11
Number of Schools Reporting Soil Moisture Data, by Month and Year

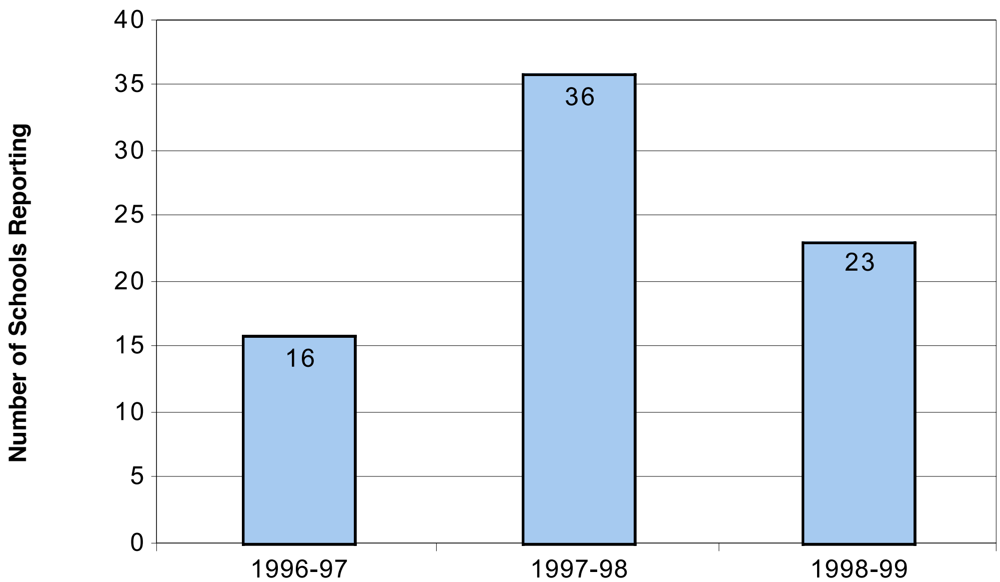


	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Soil Moisture 98-99	15	23	24	18	19	19	26	17	19	16	8	7
Soil Moisture 97-98	19	25	19	15	14	21	29	28	36	25	9	10
Soil Moisture 96-97	26	23	24	15	12	17	17	23	24	19	10	7
Soil Moisture 95-96	15	35	33	28	27	24	21	32	32	20	13	8

Less Frequent Data Types

Protocols for Soil Characterization, Soil Temperature, Land Cover, and Biometry data are either relatively new or call for less frequent data collection. Accordingly, we display the number of schools reporting these data per year (rather than per month) in Figures 4.12 through 4.15. Soil Characterizations have been reported by 71 schools since the inception of this protocol in November 1996. The Soil Characterization protocol has been slow to gain adoption in GLOBE schools. During the 1997-98 school year, 36 schools reported Soil Characterizations, an increase from the 16 reporting in 1996-97. The number of schools reporting in 1998-99 dropped to 23 (see Figure 4.12).

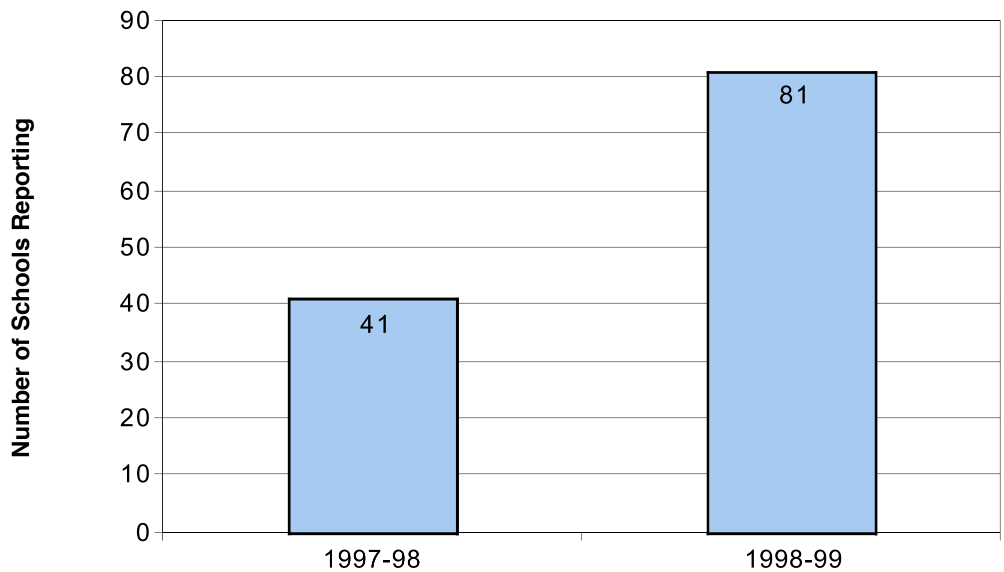
Figure 4.12
Number of Schools Reporting Soil Characterization Data, by Year



Data using the Soil Temperature protocol were first collected in October 1997, when a small number of schools participated in the data collection. However, a year later, in 1998, 41 schools had submitted 6,500 measurements, with more than half coming from a single German school that took daily measurements in two sites. In addition, 10 schools reported data on a regular basis (more than 70 data measurements over the year). This school year, 81 schools have submitted more than 7,000 Soil Temperature readings (see Figure 4.13). The protocol requests that measurements be taken weekly. Some schools submitted very high numbers of measurements, however, either reporting data from more than one site or reporting on a daily, rather than a weekly, basis.

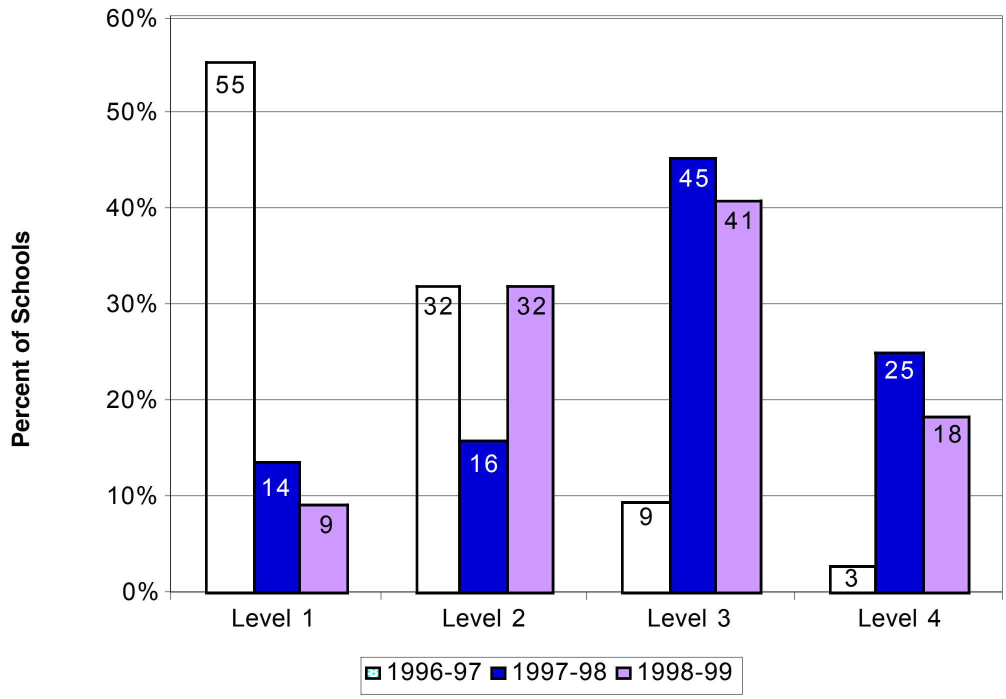
Land Cover Qualitative data have been reported from the inception of the GLOBE II protocols in October 1996 through July 1999. A total of 170 schools reported 542 Modified UNESCO Classification system (MUC) codes during the 1998-99 school year, compared with 27 schools reporting during the 1997-98 school year and 64 in 1996-97. This significant increase suggests that the GLOBE II Land Cover Qualitative protocol is gaining more widespread implementation. Like last year, the distribution of MUC codes reported continues to be more specific than those reported in previous years (see Figure 4.14). The higher code numbers indicate that the school sites are going deeper into the protocols—they have moved beyond selecting the Biology Land Cover site and assigning the MUC Level 1 category to doing more detailed classifications.

Figure 4.13
Number of Schools Reporting Soil Temperature Data, by Year



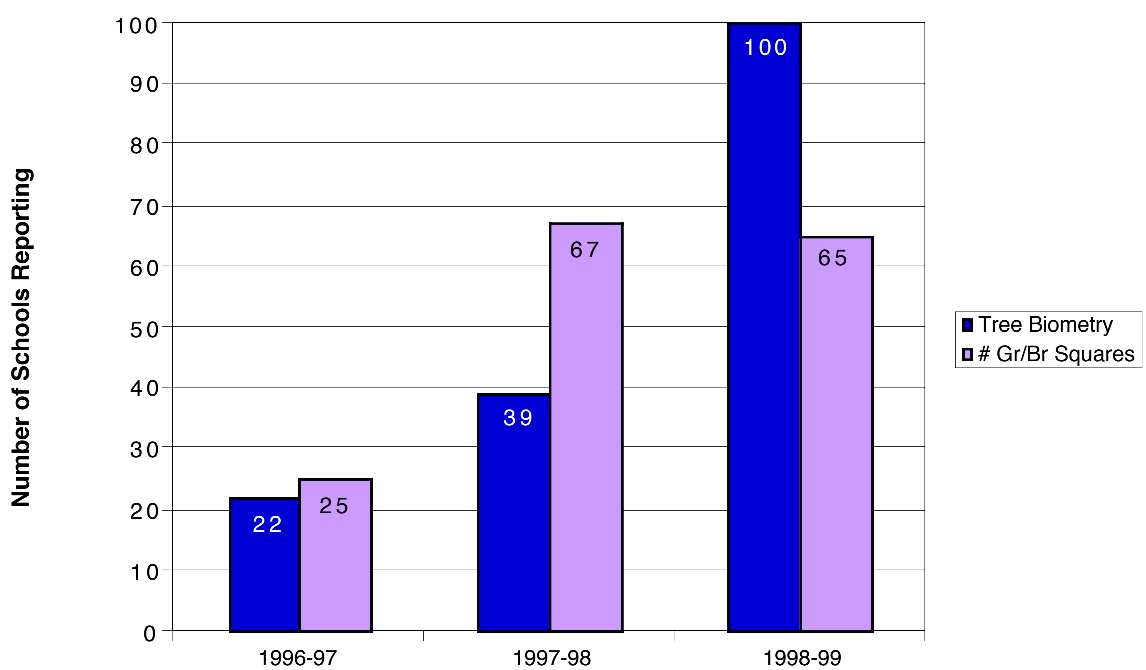
Quantitative Land Cover data reported for 1996-97 through 1998-99 generally show an increase each year in the number of schools reporting data. One hundred schools made 171 tree biometry reports in 1998-99 using GLOBE II protocols, compared with 39 schools in 1997-98 and 22 schools in 1996-97. Of the types of Quantitative Land Cover measurements, the most frequently reported were Genus, Species, Height, and Circumference of the dominant tree species. The level of reporting for the Quantitative Land Cover measurements remained stable over the past 3 years, with the exception of the counts of Green and Brown square measurements, which decreased slightly. Figure 4.15 shows the changes in the reporting patterns of these types of data over time.

Figure 4.14
Distribution of MUC Levels Reported in 1996-97, 1997-98, and 1998-99



Note: Some types of land cover can be classified only to Level 2.

Figure 4.15
Number of Schools Reporting GLOBE II
Quantitative Land Cover/Biometry Data, by Year



Average Number of Data Types Reported per School

There is some evidence to suggest that schools that are active in GLOBE are doing broader implementations than in the past. The overall number of data types that schools reported increased from 4.0 to 4.3 between Years 3 and 4. The increase in breadth is most notable for U.S. schools, which increased their average number of data types from 3.5 to 4.2 since last year. This increase is probably due, at least in part, to the new requirement to report precipitation data along with air temperature and cloud observation data.

Effects of Multiple Teachers per School on Reporting Patterns

GLOBE's promotion of the training of more than one teacher per school has been in effect long enough to permit some empirical analyses of this model's impact. We compared data reporting patterns of schools with multiple GLOBE-trained teachers to those of schools with a single GLOBE teacher. Among the subset of 1,543 U.S. schools that have had multiple teachers trained in GLOBE, 32% reported data in the 1998-99 school year. This proportion is significantly higher than the 14% of 3,932 U.S. schools with only one teacher trained that were reporting data in 1998-99. Schools with multiple trained teachers also tend to report more types of data. Of the 1,054 U.S. schools reporting data during 1998-99, the 500 schools with more than one teacher trained reported an average of 4.4 data types, compared with 4.0 data types for the schools with only one teacher trained. Of the 757 international schools reporting data during the same time period, the 229 schools with more than one teacher trained reported an average of 4.7 types of data, compared with 4.4 for the schools with only one teacher trained.

Discussion

The GLOBE Program continues to involve large numbers of teachers, schools, and students. GLOBE partners are providing an increasing proportion of the teacher training in the United States. Worldwide, more than 3,800 teachers were trained in GLOBE during Year 4, but this extensive training investment did not increase the number of data-reporting schools. Although a lag of up to 12 months between training and data reporting is common, the reporting patterns suggest a decreasing return (in terms of data collected and possibly program implementation in the broader sense) for the effort devoted to teacher training, since the current level and approach to training appear to support a steady level, rather than growth, in program activity. Data reporting can be increased either by increasing the proportion of schools that stay with the program over time or by increasing the proportion of trained teachers who implement the data collection protocols. Schools with more than one GLOBE-trained teacher report data at a higher rate than those with a single GLOBE teacher. Participating schools continue to report primarily Atmosphere data, but several of the less commonly implemented protocols—notably Land Cover, both Quantitative and Qualitative, and Soil Temperature—are starting to gain wider use.

Chapter 5. Activities of International and Franchise Partners

The survey sent to GLOBE U.S. franchises and international partners focused on their recruitment, training, and ongoing teacher support practices. Respondents were also asked about the major challenges they face in setting up GLOBE programs and the strategies they use to address those challenges. The overall response rate for the survey was 60%, with 68% of U.S. franchises and 54% of international partners returning survey forms. (See Chapter 2 for more detail.)

Primary Targets for GLOBE Recruiting Activities

Any educational innovation needs to develop a strategy for spreading or "scaling up" its implementation. Some programs seek rapid growth; others prefer to start small and perfect their approach before involving large numbers of students and teachers. Once a program is ready to spread, it must determine the best strategy for doing so. The program may appeal directly to individual teachers, or it may seek to involve groups of teachers at the same school or within the same district. GLOBE partners were asked to indicate the primary level at which they do their recruiting. Survey responses indicated that GLOBE partners do most of their recruiting at the school district level, followed by individual schools and individual teachers. More than one-third (35%) of GLOBE partners consider school districts or groups of schools their most important target of recruitment, one-quarter recruit primarily individual schools, and 20% put the most emphasis on appealing directly to individual teachers (see Table 5.1). Although many franchises do some training of preservice teachers, teacher education students are considered the most important recruiting target by only 8% of franchises. (Another 15% consider preservice teachers their second or third most important recruiting target.)

Recruiting practices differ somewhat between U.S. franchises and international partners. In U.S. franchises, the recruitment of whole school districts is the most important target (43%), followed by the recruitment of individual teachers (29%). Among international partners, almost half (45%) target individual schools, followed by the whole district (26%).

Requirements for Enrollment

Teacher training is an investment. Although some teachers pay fees to cover some of the costs involved, few pay enough to cover the real costs of GLOBE materials, trainer time, and facilities. Programs naturally want to make sure that they are investing their training resources where they will have an impact, i.e., that they are training teachers who are likely to benefit from the training and who work in settings where they have a good chance of being able to implement an effective program. For this reason, some GLOBE partners choose to make enrollment in their GLOBE training contingent on the potential participants' commitment and resources.

Table 5.1
Primary Targets for GLOBE Recruiting Activities
(Percent Reporting as "Most Important")

Focus	*United States*	*International*	*Overall*
Whole districts (groups of schools)	43	26	35
Individual schools	8	45*	25
Individual teachers	29	10	20
Teachers already enrolled in an existing program	8	8	8
Preservice teacher education students	8	0	4
Other	4	10	7
Sample sizes:	n = 49	n = 42	n = 91

* p < .05 (A difference this large or larger between the two samples would be found less than 5 times out of 100 if the samples were equal in terms of the variable being analyzed.)

Although 17% of GLOBE partners impose no enrollment restrictions, most have one or more requirements, as shown in Table 5.2. Restrictions based on the availability of material resources are the most common. Fifty-one percent require Internet access in the school or the individual teacher's classroom, and 44% require that participants have or commit to acquiring the needed measurement instruments.

Evidence suggests that participant commitment and engagement also are important. In a study of professional development practices of Statewide Systemic Initiative programs funded by the National Science Foundation, for example, Corcoran, Shields, and Zucker (1998) found that training activities were more likely to have lasting impact when multiple teachers and the principal were involved. More than one-third of GLOBE partners require endorsement by the principal (35%), and 31% require that schools send teams of teachers, rather than a single teacher.

Table 5.2
Requirements for Enrollment
(Percent Reporting)

Requirement	*United States*	*International*	*Overall*
No restrictions are placed on enrollment	26*	7	17
Schools must send a team with more than one teacher	24	40	31
School principal must participate in training	0	5	2
School principal must endorse training	30	42	35
School or teacher's classroom must have connection to World Wide Web	44	58	51
School or teacher's classroom must have, or promise to acquire, needed measurement instruments	38	51	44
Other	26	33	29
Sample sizes:	n = 50	n = 43	n = 93

* $p < .05$

Although enrollment restrictions based on availability of resources are more widely used than restrictions based on level of commitment by both U.S. and international partners, the latter type of restriction is used particularly internationally. Forty percent of international partners require that potential participants send more than one teacher for training per school, compared with only 24% of U.S. franchises. The international partners are also more likely to do their recruiting at the school rather than the individual teacher level (see Table 5.1). No U.S. franchise and few international partners (5%) require attendance by the principal at training.

Teacher Supports

Supports Provided to New Trainees

In addition to careful attention to the individuals and institutions recruited for GLOBE, partners can protect their training investment by providing follow-up support after the completion of initial GLOBE training. GLOBE partners provide support to trainees with a mix of material resources and technical assistance. Approximately 60% of new trainees receive instrument kits, assistance aligning the GLOBE activities with their national, state, or local curriculum or assessments, and assistance setting up and using computers for GLOBE, as shown in Table 5.3.

Table 5.3
Supports Provided to New Trainees
(Percent Reporting)

Support	*United States*	*International*	*Overall*
Instrument kits	58	66	62
Computers	17	24	20
Assistance getting an Internet connection	29	47	37
Assistance setting up and/or using computers for GLOBE	56	58	57
Alignment of GLOBE activities with state or local curriculum or tests	63	58	60
Other	35	39	37
Sample sizes:	n = 48	n = 38	n = 86

The overall patterns of support provided by the U.S. franchises and the international partners are similar. More than half provide instrument kits, and more than half provide assistance setting up and/or using computers for GLOBE. Almost half (47%) of international partners provide trainees with assistance getting an Internet connection, as do almost a third (29%) of U.S. franchises. Provision of computers to new trainees is less common (17% U.S. and 24% international partners).

Many GLOBE partners also report providing other supports to new trainees. These supports include travel stipends, assistance with weather station site selection and installation, assistance with obtaining equipment (e.g., providing guides to potential sources and grant applications), and written materials, such as information about measurement instruments and pedagogical materials. In the 1999-2000 school year, one franchise will be supplying a mobile van to provide classrooms with greater access to GLOBE materials.

Supports Provided to Teachers Who Have Completed Training

A range of supports, such as personal contact, supplementary instructional materials, incentives, and print documents, are being provided by both the U.S. franchises and the international partners to teachers who have completed GLOBE training. Of the 11 types of supports asked about on the survey, the most commonly provided are those that are social or collaborative in nature—including personal contact with franchise/program staff through phone call or e-mail, site visits by franchise/program staff, and meetings and conferences to share experiences.

The most commonly implemented support, reported by 80% of respondents, was personal contact via phone call or e-mail. The extent of other supports provided ranged from 63% for site visits to 19% for participation incentives, such as equipment or recognition for reporting data.

The survey data indicate that international partners are more likely than the U.S. franchises to provide 3 of the 11 specific types of support listed on the survey. International partners more often provide a newsletter (31% versus 10%), and supplementary materials (59% versus 33%). These differences may relate to factors such as the desire to convey a country-specific presence and the need to provide alternative materials for teachers in countries with limited or no access to the World Wide Web. International partners are also more likely to provide meetings and conferences (77% versus 48%). Supports involving face-to-face contact, such as visits by GLOBE mentor or master teachers, arranged contacts with scientists, and site visits by program staff are equally common in U.S. franchises and international GLOBE programs.

Support Activities in Context

Table 5.4 shows the frequency with which GLOBE partners are using different support and follow-up strategies, but it lacks a basis for evaluating the record of these GLOBE partners in comparison with other programs aimed at influencing teacher practice. A study conducted by Ruskus and Luczak in 1994–95 provides the needed point of comparison. Six federal agencies (Department of Energy, Department of Education, NASA, the National Institutes of Health, NSF, and the Smithsonian Institution) nominated science and technology teacher professional development efforts they had funded as "exemplary." These 34 programs were visited by researchers from three research firms conducting the evaluation, using structured data collection instruments to document, among other program elements, the specific follow-up and support services offered. Using the program profile prepared by Ruskus and Luczak (1995), the SRI evaluation team was able to score each of these reputedly exemplary programs for the number of follow-up practices listed on our Partner Survey that they employed. Whereas these exemplary teacher professional development programs used an average of 1.91 follow-up strategies, the GLOBE franchises reported 4.48. Even allowing for some bias associated with the different data collection approaches, the difference is large enough to suggest that GLOBE partners are unusually strong on this dimension.

Impact of Teacher Supports

As described above, GLOBE partners provide a wide range of supports to their trainees to maximize the prospects for the trainees' successful implementation of the program. The data maintained by the GLOBE Program on data-reporting history of schools with GLOBE teachers trained by GLOBE franchises permitted an initial empirical investigation of the extent to which these supports are paying off in terms of higher data reporting.

Those U.S. franchises included in the May 1999 GLOBE Program Franchise Summary Report that had trained teachers from at least five schools and that had returned a Partner Survey were included in the analysis.[1] The outcome measure, percentage of schools that had ever reported GLOBE data, was computed for each of the 33 U.S. franchises that met these criteria.

The number of new trainee and follow-up supports provided by these 33 franchises, as indicated on their surveys, was computed. The maximum number of supports possible was 18; franchises in our subsample had provided from 2 to 12 of these supports. The subsample was then divided into three groups on the basis of total number of supports provided. The high-support group (n = 12) provided from 10 to 12 supports and the low-support group (n = 13) from 2 to 6 supports. It was expected that high levels of support from the franchise would be associated with higher levels of reporting by the franchise-trained schools.

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[1] Schools that had worked with fewer than five schools were excluded from the analysis both because they were less likely to have well-established training and support programs and because of inadequate stability in the outcome measure (proportion of schools that had reported GLOBE data) when the sample of schools is so small.

Table 5.4
Supports Provided to Teachers Who Have Completed Training
(Percent Reporting)

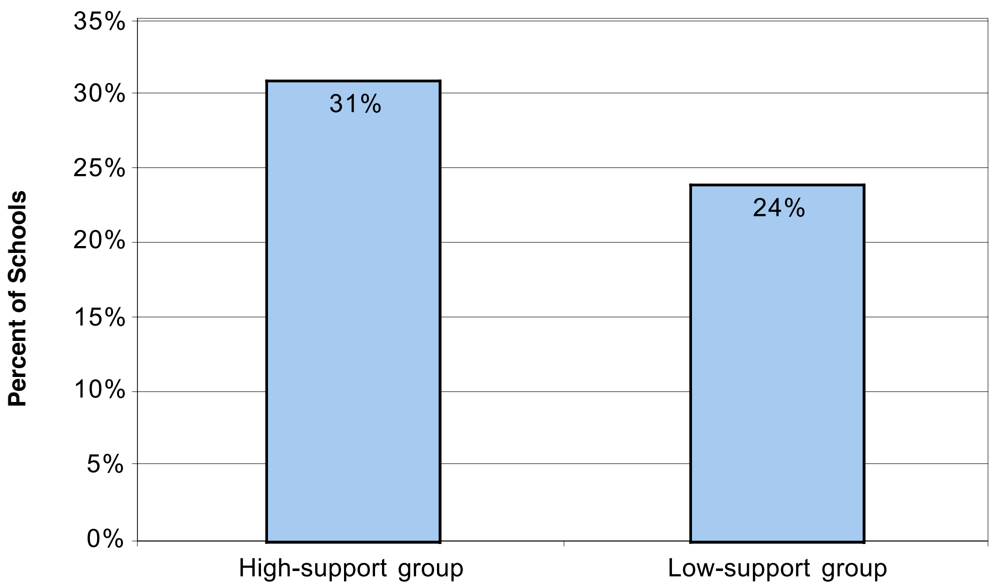
Support	*United States*	*International*	*Overall*
Teacher listserv	38	46	42
Meetings, conferences to share experiences	48	77*	62
Local GLOBE newsletter	10	31*	20
Supplementary materials (e.g., implementation tips)	33	59*	46
Personal contact with franchise/program staff through phone call or e-mail	88	72	80
Site visits by franchise/program staff	67	59	63
Visits by designated GLOBE mentor or master teachers	31	33	32
Arranged contacts with scientists	36	38	37
Refresher training sessions	45	51	48
Participation incentives (e.g., equipment or recognition in return for reporting certain types or amounts of data)	14	23	19
Monitoring and feedback on data reporting contributions	31	51	41
Other	7	26*	16
Sample sizes:	n = 42	n = 39	n = 81

* $p < .05$

We found that for franchises providing a broader set of teacher supports, 31% of their associated schools had reported GLOBE data, compared with 24% for those franchises providing a narrower range of teacher supports, as illustrated in Figure 5.1. Although this difference is in the predicted direction, it did not attain statistical significance, given the small size of our franchise sample and limited number of schools trained to date by most franchises. Correlations between individual franchise practices and school reporting, for the most part, also did not attain significance and were generally low in magnitude. The only support practice that correlated significantly with school data reporting was running a franchise teacher listserv ($r = .42$, $p < .05$). The only other survey item that correlated significantly with school reporting was perceived magnitude of the challenge of obtaining needed funding. Franchises that regard fund-raising as a bigger challenge have a lower proportion of schools reporting data ($r = -.44$, $p < .05$).

As U.S. franchises train teachers from more schools, a larger data set will become available for analysis in the near future. Moreover, the Teacher Survey planned for spring 2000 will include items that can be treated as additional outcome variables (for example, variables related to quality of classroom implementation, such as the involvement of a broad set of students and incorporation of data analysis and interpretation activities). Further statistical investigations of the relationship between franchise support activities and program outcomes are planned as part of next year's evaluation activities. The goal is to identify patterns of teacher recruitment and support that are linked to higher-quality implementations.

Figure 5.1
Percent of Schools Reporting Data Linked to Sample of High- and Low-Support-Providing Franchises



Affiliation of Trainers

Another dimension of variation across GLOBE partners is the institutional base and experience of trainers. Historically, GLOBE has stressed the use of multidisciplinary training teams, including environmental education specialists, scientists, and active teachers. There is variation across partners, however, in the particular mix of trainers.

Some franchises use primarily faculty from a school or college of education; others rely more on faculty from science departments or an environmental agency, for example. Whereas one type of trainer may be particularly adept at drawing connections to classroom curriculum and instructional approaches, other types may better convey the sense of scientific authenticity that sets GLOBE apart from other science education programs. The survey asked partners to indicate the affiliations of their trainers. Table 5.5 displays their responses. The most prevalent affiliations of GLOBE trainers are college and university science departments (54%) and high schools (46%). About one-third of all partners use trainers affiliated with college or university education departments, 30% draw on staff from environmental agencies, and 28% use one or more middle school teachers as trainers. Partners obtain trainers from a variety of other organizations as well, especially for international GLOBE programs. International partners have obtained trainers from space agencies and from Peace Corps volunteers, for example.

Table 5.5
Affiliation of Trainers
(Percent Reporting)

One or more from	*United States*	*International*	*Overall*
College or university education department	36	32	34
College or university science department	62	43	54
College or university other department	27*	8	18
Elementary school (grades K-5)	24	11	18
Middle school (grades 6-8)	36	19	28
High school (grades 9-12)	49	43	46
Informal science education center (e.g., park or museum)	27	19	23
Environmental agency (e.g., national weather service or soil conservation agency)	22	41	30
Other (e.g., space agency, Peace Corps)	33	49	40
Sample sizes:	n = 45	n = 37	n = 82

* $p < .05$

The sources for trainers for international and U.S. training sites are similar. Members of university science departments and high school teachers are the most commonly used trainers both in the United States and abroad. International partners do appear to rely more heavily on trainers from environmental agencies than do U.S. franchises (41% international, compared with 22% of U.S. franchises), but the difference is not statistically significant. In fact, the only statistically significant difference between franchises and international partners is the greater likelihood for U.S. franchises to involve trainers from university departments other than science or education.

Training Time

Time Devoted to Protocols

Earlier evaluation reports have documented large differences across the different GLOBE investigation areas in the proportion of teachers implementing the investigation protocols (Means, Coleman, & Lewis, 1998). Atmosphere protocols are by far the most likely to be implemented, followed by Hydrology protocols. Land Cover/Biology and Soil protocol implementation rates lag far behind. Teacher reports indicate that factors such as protocol complexity, availability of necessary equipment, and linkage to the curriculum enter into the decision of whether or not to implement a particular protocol. Another possible factor is the extent to which the protocol is covered in training. If a teacher’s training skips or merely skims over the protocols from a given investigation, it seems logical that the teacher would be less likely to include those protocols in his or her classroom activities. GLOBE partners were asked to indicate the amount of time their training devotes to protocols in each of the GLOBE investigation areas. In reviewing their responses, shown in Table 5.6, it should be remembered that the investigation areas differ in both the number and the complexity of protocols they contain. The time allocations recommended by the GLOBE Program, shown in Exhibit 5.1, provide an indication of the relative complexity and quantity of content in the various investigation areas. The GLOBE Program recommends spending more time on Hydrology, Soil, and Land Cover/Biology than on Atmosphere or GPS.

The amount of time GLOBE partners say they devote to training on the data collection protocols varies considerably across investigation areas. The GPS protocols, which are only two in number, receive the least amount of time. The Atmosphere protocols receive more time than GPS but less than either Hydrology or Land Cover/Biology protocols. Soil protocols are the most likely to receive more than 3 hours of coverage in training, but they are also the most likely to be skipped altogether (as reported by 8% of partners). Approximately half or more of franchises and partners devote more than 3 hours of time to three of the five protocol areas (Hydrology, Land Cover/Biology, and Soil).

Table 5.6
Time Devoted to Training GLOBE Protocols
(Percent Reporting)

	United States				*International*				*Overall*			
Protocol	No time	< 1 hr.	1-3 hrs.	> 3 hrs.	No time	< 1 hr.	1-3 hrs.	> 3 hrs.	No time	< 1 hr.	1-3 hrs.	> 3 hrs.
Atmosphere	0	5	61	34	3	24	50	24	1	13	56	29
Hydrology	2	0	30	68	3	13	58	26	2	6	43	49
Land Cover/Biology	2	0	35	63	5	24	37	34	4	11	36	49
Soil	0	5	9	86	16	14	38	32	8	9	23	61
GPS	0	48	43	9	8	55	37	0	4	51	40	5
Sample sizes:	n = 43-44				n = 37-38				n = 80-82			

U.S. partners are more likely than international partners to devote extensive time (more than 3 hours) to Hydrology, Land Cover/Biology, and Soil protocols. Within U.S. franchises, those providing a broad range of teacher supports provide more hours of training (38 hours) than those providing a narrower range of supports (33 hours).

Time Devoted to Learning Activities

Like the GLOBE protocols, the amount of time spent on GLOBE learning activities varies by investigation area (see Table 5.7). With the exception of the Seasons learning activities, "less than 1 hour" and "1-3 hours" were the most frequent time allocations for the activities for a given investigation. By comparison, 45% of GLOBE partners reported spending *no time* on the Seasons learning activities, and only 23% reported spending an hour or more.

The international partners tended to report spending fewer hours for training on the learning activities, significantly less in the case of Soil and Seasons. Thirty-nine percent of international partners said they spent no time on Soil learning activities; 67% spent no time on Seasons.

Exhibit 5.1
GLOBE Workshop Time Allocation Recommendations

GLOBE Workshop Agenda Analysis	Recommended Number of Hours
Protocols and Activities	
Atmosphere	1.75
Hydrology	6.00
Soil	6.50
Land Cover/Biology	5.25
Remote Sensing	1.25
GPS	.75
Seasons	.75
Other Activities	
Introduction	2.75
Visualization, use of graphing tools, and identification of schools and data sets	1.75
MultiSpec	1.75
Registration	.50
Workshop logistics, introduction to GLOBE and Teacher's Guide	2.00
Presentation on science values and learning communities	1.00
Implementation of GLOBE in the classroom (teacher educator discussion)	1.50
Development of implementation plans and strategies	2.00
Presentation of implementation plans by participants	1.50
Completing evaluation forms	.25
Final exam/GLOBE test	.75
Graduation	.50
Questions and answers	.75
Total	17

Note: Modified from GLOBE Training Resource Room PDF document.

In interpreting these training time distribution data, it should be remembered that the various investigations differ both in the number of learning activities and protocols included and in the complexity of those materials. We would not expect an equal amount of time to be spent for each investigation.

Table 5.7
Time Devoted to Training on GLOBE Learning Activities
(Percent Reporting)

Learning Activity	United States				International				Overall			
	No time	< 1 hr.	1-3 hrs.	> 3 hrs.	No time	< 1 hr.	1-3 hrs.	> 3 hrs.	No time	< 1 hr.	1-3 hrs.	> 3 hrs.
Atmosphere	5	45	38	12	14	51	32	3	9	48	35	8
Hydrology	5	36	38	21	16	41	35	8	10	38	37	15
Land Cover/Biology	5	30	42	23	19	32	35	14	11	31	39	19
Soil	5	34	39	22	39	25	25	11	21	30	32	17
Seasons	26	44	21	10	67	19	11	3	45	32	16	7

Sample sizes: n = 39-43 (United States); n = 36-37 (International); n = 75-80 (Overall)
* p < .05

Time Devoted to Other GLOBE Topics

GLOBE training also includes use of supporting technologies and planning for GLOBE implementation. Generally speaking, half or more of the GLOBE partners spent at least 1 hour of their training time on each of these topics. Fewer than 10% of partners failed to cover GLOBE data reporting forms, data visualizations, curriculum integration, and implementation planning in their training, as shown in Table 5.8. Seventy-nine percent of partners reported covering MultiSpec, with 60% giving it an hour or more.

The time spent on mentoring/feedback on implementation steps taken between training sessions presents a different pattern. There is a greater range in the amount of time spent on this topic, with 21% spending no time and 23% spending more than 3 hours. It should be noted that inclusion of this activity during training is possible only for those 66% of GLOBE partners that spread their training sessions out over an extended time period (e.g., four weekends) rather than holding them on successive days.

Table 5.8
Time Devoted to Training on Other GLOBE Topics
(Percent Reporting)

Topics	United States				International				Overall			
	No time	< 1 hr.	1-3 hrs.	> 3 hrs.	No time	< 1 hr.	1-3 hrs.	> 3 hrs.	No time	< 1 hr.	1-3 hrs.	> 3 hrs.
Use of GLOBE data reporting forms	0	38	48	14	5	42	39	13	3	40	44	14
Use of GLOBE data visualizations	2	23	53	21	16	24	55	5	9	23	54	14
Use of MultiSpec	16	16	47	21	28	22	36	14	22	19	42	18
Integrating GLOBE with local curricula	5	23	50	23	11	43	35	11	7	32	43	17
Implementation planning	2	28	44	26	6	49	37	9	4	37	41	18
Mentoring/feedback on implementation steps taken between training sessions	11	32	24	34	31	29	29	11	21	30	26	23
Sample sizes:	n = 38-44				n = 35-38				n = 73-81			

Total Training Time

A major criticism of teacher professional development programs in general is that they are too brief to have any long-term effects (Darling-Hammond & Ball, 1997). The number of training hours provided is a simple but telling index of the intensity of training. Although time spent is not necessarily spent well, some minimum amount of time is certainly needed to cover a science education program as rich and multifaceted as GLOBE. Exhibit 5.1 shows the minimum training time recommended by U.S. GLOBE for its contract trainers, by investigation area. (The hour figure for each investigation is a recommended hourly minimum for protocols and learning activities together.) The total number of recommended hours, excluding meal breaks, is just over 39.

The Partner Survey asked for the total number of hours involved in the partner's GLOBE training. The number of training hours provided by U.S. franchises ranged from

15 to 80, with an average of 36. Although 40 hours was the most commonly reported total time allocation and the average across all franchises was close to the minimum time recommended by the GLOBE Program, 56% of franchises reported spending less than the recommended 39 hours on teacher training prior to certification.

Extent That Fund-Raising Has Been a Challenge

GLOBE partnerships function on a no-exchange-of-funds basis, and both U.S. franchises and international partners must find funding to support their activities. Eighty-three percent of GLOBE partners reported that fund-raising is a challenge; 47% viewed it as a major challenge (see Table 5.9). More than half (53%) of the international partners reported that obtaining funds is a major challenge, compared with 42% of U.S. franchises.

Table 5.9
Extent That Fund-Raising Has Been a Challenge
(Percent Reporting)

Challenge Level	*United States*	*International*	*Overall*
Not a challenge	21	13	17
Minor challenge	9	13	11
Moderate challenge	28	23	25
Major challenge	42	53	47
Sample sizes:	n = 43	n = 40	n = 83

Other Challenges

The Partner Survey asked respondents to describe the greatest challenges other than fund-raising, in their own words. Survey responses were entered into an electronic database, and qualitative data analysis software called NVivo was used to identify and tabulate response patterns.

Analysis of the partners' write-in responses identified eight themes:

- Providing follow-up supports such as mentoring and networking to teachers

- Gaining political and institutional support
- Obtaining and maintaining equipment
- Getting and retaining partner scientists
- Aligning GLOBE with existing curriculum and assessment mandates
- Developing partnerships to support the program
- Recruiting teachers
- Recruiting trainers.

Table 5.10 shows the frequency with which each of these themes appeared in the write-in responses. (Unclear or ambiguous responses were not included in this analysis.)

Table 5.10
Challenges Cited in Open-Ended Responses
(Number Reporting)

Challenge Type	*United States*	*International*	*Overall*
Providing follow-up supports to teachers	20	13	33
Gaining political and institutional support	3	13	16
Obtaining and maintaining equipment	6	8	14
Getting and retaining partner scientists	2	6	8
Aligning GLOBE with curriculum and assessment mandates	4	4	8
Developing partnerships	3	2	5
Recruiting teachers	4	1	5
Recruiting trainers	4	0	4
Sample sizes:	n = 48	n = 75	n = 123

Follow-up Supports for Teachers

Providing follow-up supports to teachers who have completed GLOBE training was the most commonly discussed challenge overall and among U.S. franchise partners. GLOBE franchises clearly feel responsibility to follow up with previously trained teachers but often lack funds, personnel, and time to do the follow-ups they would like to do. Follow-up support may be particularly challenging for franchises attempting to cover a large geographic area.

> *"Keep teachers in sites distant…interested and active in GLOBE activities"*
>
> *"Having enough mentors to provide help in rural areas"*
>
> *"Time for trainers to visit and assist individual school sites"*
>
> *"Reviving schools that received training in the program and have been overwhelmed or just given up trying"*
>
> *"Follow through networking, time to do what could be done"*
>
> *"Providing necessary follow-up support—will take staff time"*
>
> *"Increasing active and full participation in the program by schools"*

Political and Institutional Support

Gaining political and institutional support is a key challenge in the minds of international partners. The comments below suggest that these partners see their governments as central to the implementation of the GLOBE Program, and ministry-level commitment is something that must be continuously nurtured and renewed.

> *"Ensuring ongoing government commitment to GLOBE"*
>
> *"Misunderstanding from officials"*
>
> *"Coordination with ministry of the environment to others"*
>
> *"Low interest of the state governments, especially Ministry of the Environment and Ministry of Education"*

Obtaining Equipment

Obtaining needed equipment is sometimes difficult, particularly for international partners. A few international partners report severe difficulties meeting equipment needs. They lack the basic GLOBE equipment, "measurement equipment, computers, Internet connections." If the partners do obtain equipment needed inside the school, problems may exist outside of the school. One partner reports that the local infrastructure currently does not provide "reliable mail and phone lines."

> *"Providing more support for computer training and infrastructure of computers in schools"*
>
> *"Since we haven't actually done a training yet, getting the materials together and ordering the kits, etc. has been a challenge."*
>
> *"Vandalism of the equipment which is sporadic but ongoing. The damage is not caused by students at the GLOBE schools."*

Developing Partnerships and Getting Scientists Involved

Active involvement of scientists is another challenge cited frequently by international partners.

> *"Creating effective links with local scientists"*
>
> *"Involving national scientists in using students' GLOBE data"*
>
> *"Involving scientists (national) in GLOBE"*
>
> *"To … actively involve … scientists with efficient use of collected data"*

Developing partnerships can be an important factor in successful implementation of GLOBE because the resources needed to provide training and follow-up typically come from more than one organization. Partner responses indicate a variety of ways in which their GLOBE programs are dependent on partnerships for providing trainers, as well as funding.

> *"Leveraging GLOBE with other potential funding initiatives"*
>
> *"Other than funding, time for conducting workshops is the greatest challenge. Faculty members have schedules that are already full with university obligations."*

Curriculum Alignment

Aligning GLOBE with existing curriculum and assessment mandates is a challenge for some respondents, both U.S. and international.

> *"Convincing local teachers and administrators and science teachers that GLOBE can and will fulfill and extend their curriculum"*
>
> *"Helping teachers really make the integration of GLOBE into the curriculum so it is not perceived as an 'add-on' but as another set of tools with which to teach."*
>
> *"Large integration of GLOBE activities in state curricula"*
>
> *"Major difficulties, pointed out by the teachers, concern the present educational system – national curricula, national exams, overloaded schools, time schedule, coordination obstacles within each school."*

Recruiting

Some U.S. franchises mentioned difficulties recruiting teachers and trainers.

> *"Obtaining the number of teachers due to the extensive training that is necessary."*
>
> *"The biggest challenge is to get more trained presenters."*
>
> *"Also finding qualified people to teach the protocols was a worry."*

International perspectives on these issues are described further in Chapter 7.

Discussion

Survey responses indicate that GLOBE partners and franchises have initiated a broad range of supports to provide to teachers at the time of their training and subsequent to it. Although we do not yet have a long enough track record with enough different partners to establish relative effectiveness of the different support strategies empirically, we will examine this issue in future analyses.

GLOBE partners have responded to the need for resources they have difficulty providing by forming partnerships with other organizations. In this way, high-quality implementation can occur. Chapter 6 describes the operation of selected U.S. franchises, giving examples of these partnerships, and Chapter 7 provides additional description of some of the international programs.

Chapter 6. Franchise Case Studies

Introduction

Sustaining school interest and teacher and student involvement over time is a key challenge of educational change initiatives (Elmore, 1996; Ruskus & Luczak, 1995; Tyack & Cuban, 1995). Many educational innovations, particularly those calling for a combination of sophisticated content and inquiry-oriented instructional approaches, make large demands on teachers. Not surprisingly, research studies find that teacher attrition rates from such educational initiatives are extremely high.

The teacher attrition problem is further exacerbated by the significant rate at which teachers transfer between schools or leave the profession altogether. For example, in the state of California, 50% of all new teachers leave the profession within the first 5 years (see SRI International, 1999). If teacher skill and knowledge are among the key determinants of students' opportunities to learn, keeping effective teachers in schools for longer periods of time must be regarded as one of the major challenges facing education (SRI International, 1999).

In recognition of these challenging education realities, the GLOBE Program initiated a new regional model of training for U.S. teachers and schools. This "franchise" training model was designed to stimulate and build on local and regional "communities of expertise and practice." The GLOBE Program sought two advantages for scalability from this approach:

- To make programmatic growth possible without increasing federal investment
- To further augment the ongoing support and follow-up contact with GLOBE teachers.

The rationale for regional franchise training, as opposed to national training administered by the GLOBE Program, is based on the assumption that franchise partners can better serve and support more teachers (i.e., provide broader coverage), as well as offer more continuous support to trainees through local contacts when problems arise or changes to the programs are made. The GLOBE Program office believed that this type of support would be less feasible within a national training system.

To develop a franchise, a nonprofit entity such as a school district, university, state department of education, or other educational organization signs a joint agreement with GLOBE to recruit, train, and mentor GLOBE teachers within its area.

Case Studies: How Franchises Address Common Challenges

During the winter and spring of 1999, we conducted site visits to four franchise training sites across the United States, in an effort to develop a deeper understanding of how GLOBE franchises work. Our case studies included site visits to training sessions facilitated by franchises, observations at GLOBE schools trained by franchises, and interviews with franchise staff, teachers, and other partners who play significant roles within the franchises. In our observation and interview protocols, we attempted to learn about the ways that different contexts—at the franchise, district, and school levels—shaped GLOBE implementation and informed the guiding vision and practices of different franchises. The case studies, moreover, allow us to look more deeply at some of the challenges that coordinators identified in the Partner Survey. In this chapter, we focus on some of the challenges that were identified as common to a majority of franchises and identify ways that case study franchises addressed those challenges in their training design and practice, follow-up support, and partnership development.

Case Study Site Selection

Four sites were selected for the case studies: (1) Los Angeles Unified School District, (2) “GLOBE in Alabama” (3) The University of North Carolina at Chapel Hill, and (4) The University of South Carolina at Aiken. These four sites met the combination of program-related and pragmatic criteria for inclusion described in Chapter 2.

Looking across the four franchise case study sites, we then identified examples of how these four franchises have dealt with major challenges identified in the Partner Survey.

Recruiting Teachers to Participate in GLOBE

As training becomes more accessible to teachers through franchises, recruiting teachers who cannot travel to distant regions to learn about GLOBE but who are nonetheless interested in participating can be a challenge. Franchises must develop strategies to reach groups of teachers and identify people within districts and schools who can provide incentives for teachers to participate. In South Carolina, the franchise itself helps pay for equipment for teachers and pays for substitutes for teachers who attend GLOBE training. In Alabama, the franchise works closely with district staff to recruit teachers, rather than targeting individual teachers. This franchise has encouraged districts to pay for equipment and arrange for substitutes for teachers to attend the training. This approach has worked particularly well in Jefferson County (Alabama), where the district science coordinators are GLOBE in Alabama trainers who help out with training and equipment and give teachers time during the school day to attend GLOBE training.

Figure 6.1
Hydrology Training at the Los Angeles Franchise

In North Carolina, GLOBE works with district science coordinators to identify potential teachers and has also recruited groups of teachers from a cluster of schools who train and implement GLOBE together, providing support to each other within the school and between schools. The clusters are often already organized around other math, science, and technology reform initiatives that bring teachers together to meet and plan activities. In addition, the franchise publishes a regular newsletter and maintains a listserv to keep teachers informed of GLOBE activities and to maintain connections with teachers after the training is over.

Identifying GLOBE Trainers

Identifying trainers with expertise in teaching protocols, learning activities, and the science behind GLOBE can be a challenge for any franchise. Potential trainers have other demands on their time, and in some areas, scientists and educators with both expertise and interest in GLOBE may not be readily available. In North Carolina, trainers from several agencies and universities share responsibility for training. The trainers have a long history of working together on different science and math initiatives and therefore bring not only experience of collaboration but expertise in school reform to GLOBE. The training is structured, moreover, so that each trainer can attend one day of the four-day training that focuses on their domain of expertise, freeing them from having to take four days off from their other work. In Alabama, the franchise has adopted a regional approach to training within the state. In the fall, for example, the coordinator will go to the Mobile area to help train teachers from southern Alabama in two or more investigation areas and then provide training to teachers in the Birmingham area in the spring. He typically breaks the training into two or more components, so that there is an opportunity to meet with teachers at least twice, once during the school year after they have had a chance to implement one or more protocols with their students. At the University of North Carolina, franchise coordinator Pat Bowers and the GLOBE trainers from the North Carolina Department of Public Instruction and Department of Environment and Natural Resources have a long history of working together on a variety of science and math educational reform activities.

Adapting GLOBE to Local Circumstances

In designing training sessions for local teachers, GLOBE franchise trainers are all faced with the challenge of addressing the concerns of those teachers. Franchise trainers must consider how to integrate GLOBE into local curriculum and standards set by districts and states, how to adapt GLOBE learning activities to different grade levels, and how to ensure that teachers become practiced in conducting protocols and reporting data. Moreover, teachers' needs are often complex, and implementing programs like GLOBE requires teachers to integrate program components with existing classroom goals, structures, and processes. For example, teachers being trained in GLOBE sometimes find that covering the interdisciplinary environmental science content of GLOBE infringes on other teachers' "turf." In South Carolina, one high school math teacher described being chastised by the physics teacher at her high school for teaching pH. The physics teacher felt that pH was science territory not to be infringed upon by math!

Alignment with Local Curriculum Standards

Each franchise we observed has developed strategies for addressing teachers' concerns about GLOBE's alignment with local and state standards and curricula. For example, in North Carolina, the fourth day of GLOBE training was spent leading the participants through the North Carolina curriculum standards, discussing the logistics of implementing GLOBE, and designing an implementation plan. A representative from the North Carolina Department of Public Instruction facilitated a session with teachers to brainstorm and identify how GLOBE activities fit into the standard course of study for North Carolina. Participants were given a document containing the standards for study. This document contained the various interdisciplinary foci that provide a context for teaching science and the various competency goals and objectives for student learning. Teachers were divided into different groups based on protocols (Hydrology, Soil, etc.), and each group discussed how their protocols could be addressed in the school curriculum, correlating GLOBE activities with the goals and objectives of the standards document.

In Alabama, franchise trainers emphasized that GLOBE helps meet the state's new, rigorous graduation requirements and also identified ways that GLOBE ties in with the state's science curriculum. The two district science coordinators for Jefferson County Public Schools assisted with the training, and at different points during the training session, they interjected suggestions of how the protocols could be used in contexts appropriate for different grade levels and how they fit the local curriculum. One of the coordinators made explicit links between GLOBE protocols and the district's third-grade unit on plant studies, the fourth-grade unit on ecosystems, and the fifth-grade unit on land forms, for example.

Using GLOBE with Different Grade Levels

GLOBE teachers' needs also vary by grade level: many teachers adapt learning activities and select protocols to implement on the basis of their students' own development. According to one teacher trained by the Los Angeles Unified School District franchise:

> *"I find that I have to, for my particular grade level this year, do a lot of downshifting. I have to read through it [the GLOBE manual] because I believe it's written to the upper—middle and upper—grade kids in elementary and middle high school kids. That's fine, 'cause they're the ones who have greater understanding and they comprehend the connections, and what we're doing in the primary grades is help the children become familiar, to be prompted for these experiences as they come along so they won't have to fall to the ground."*

Los Angeles Unified School District's solution is to provide training on an "adult level" first, to help teachers gain an understanding of the different concepts in GLOBE, and then to break down protocols and learning activities in a way that students might be able to understand. To ensure that the training meets teachers' needs, during one of the afternoon sessions a blank poster board was posted with the title "A Day for You—What Do You Need?" The trainers allotted time for a teacher-led discussion whereby teachers were encouraged to sign up for various activities for which they needed more training and support (e.g., MultiSpec, Soil or Hydrology protocols).

Teachers working in elementary settings often lack a strong background in science, and this lack is seen as a limiting factor for many teacher enhancement programs in science (Corcoran, Shields, & Zucker, 1998). The approach to addressing the needs of teachers working at different grade levels is one area where GLOBE franchises vary widely in philosophy and approach. For example, in North Carolina, trainers broke teachers into grade-homogeneous groups to discuss implementation issues. One group for K-2 teachers and another group for grade levels 3-6 discussed the practicalities of integrating GLOBE at their particular grade level. The observed South Carolina and Alabama training sessions, on the other hand, used grade-heterogeneous teacher groupings. In Alabama, this choice was made with the conscious intention of focusing less on age-related concerns and more on the protocols themselves. In South Carolina, the GLOBE trainer with an elementary education background kept an informal "watch" over the elementary teachers in the grade-heterogeneous groups to make sure they were not feeling overwhelmed. She interjected brief one-on-one coaching whenever is seemed useful.

Giving teachers enough time to practice protocols—in other words, doing field study and not just listening to lectures—is a critical component of franchise training. Across all the training sessions we observed, considerable time was spent allowing teachers to take atmosphere measurements, conduct soil analyses, document land cover, and the like. For the most part, moreover, teachers believed the training was a successful blend of field study and in-class formal learning.

Figure 6.2
MultiSpec Training

Adapting GLOBE to Local Geography

The franchise trainers often made fieldwork accessible through their knowledge of local geography. In Alabama, for example, the training was held at Hunstville's Botanical Gardens, and teachers could carry out Land Cover protocols on a landscape that had been designed to reflect Alabama's mixed hardwood and pine forests. In South Carolina, trainers adapted the training content to the area's geography and made clear some of the implications for protocols this geography raises. For example, at the Savannah River site, where GLOBE training was held, the trainer cautioned, "The soil has a really large sandy area here. If it's been dry, the sand won't hold in the auger."

Poor schools in urban areas have proven to be challenging settings for implementing GLOBE, for several reasons. Franchises attempting to serve these schools must offer teachers strategies that work in environments that lack green areas for taking soil samples or measuring tree canopy. For example, in Los Angeles, tight school budgets make it very difficult to maintain grassy fields. Grass has been replaced with asphalt, and areas where students can see trees on school grounds are minimal. Requirements for teaching English language learners pose additional barriers. Vandalism of GLOBE equipment is sometimes more frequent in low-income, urban areas. Finally, urban areas face more severe shortages of qualified teachers than those confronting their suburban or small-town counterparts. Teachers have been reluctant to become certified in math and science, reports one Los Angeles teacher, and reforms like GLOBE that involve serious science are viewed with skepticism. Nevertheless, enthusiastic teacher trainers are bringing GLOBE to urban teachers through a few organizations, such as the Los Angeles franchise (see Figures 6.1 and 6.2).

One strategy that franchises can use to provide services for poor urban schools is to form partnerships with recreation and parks departments. At 122nd Street Elementary School in Los Angeles, they are forming a collaboration with the Irving Magic Johnson Park. The park manager agreed to allow GLOBE students to conduct their soil analyses and to test water samples from the duck pond.

Providing Equipment to Schools and Teachers

One of the barriers many teachers face is securing the equipment necessary to carry out GLOBE protocols. Their schools may not have the budgets to purchase equipment, or the equipment may not be immediately accessible to them. Franchises have tried a number of strategies to address this problem. In Los Angeles, for example, individual teachers can call the district to ask to borrow GLOBE equipment sets. There are not enough sets of equipment for each teacher to keep at the school, but franchise staff at the district are able to take requests from teachers and often drive 30 to 40 miles across this large district to transfer equipment from one school to another. As one GLOBE teacher said:

> *"When I needed implements for an inservice program in November, they got on their little network of phones and found out that some of them could be brought up from Van Nuys, some from San Pedro, some of it from Mono Lake, and they took it down to San Pedro and San Pedro kind of drove it out here. So in two days I had everything I needed….If I ever needed anything from John [the franchise coordinator], while he may or may not have*

answered by the date, I've either had a fax or got an e-mail or he phones me or he drops by….We were short two GPS units and here comes this guy walking through all this crowd of people, holding these GPS, and yells up, 'Do you need these two?'"

In some cases, franchises themselves have been able to provide equipment to teachers. In South Carolina, the franchise supplies the elementary GLOBE kit to each school with teachers who complete the training. The trainers report that the price of the GLOBE kit would be the whole year's equipment budget for more than one teacher in their area. Moreover, when the franchise provides a school with equipment, the franchise staff have more leverage when they call teachers or principals to "make sure the equipment is getting used."

In North Carolina, the University of North Carolina at Chapel Hill (UNC) franchise tries to work with schools so that there is some cost sharing on the purchase of equipment. There is some state support from the state's Department of Public Instruction (DPI) and from Eisenhower funds to provide instruments and other materials to the teachers. The DPI representative at the observed UNC training session offered to purchase GLOBE kits for any participants who formally requested them. The Alabama franchise also leverages other funding sources to pay for equipment for its GLOBE teachers. Through a grant from the state's environmental license tag fund, the franchise coordinator was able to buy some equipment for some GLOBE schools, and he has strongly encouraged districts where he has trained teachers to support GLOBE by purchasing equipment for their schools. Franchises have been successful in obtaining funds from other sources, such as the U.S. Department of Education Technology Innovation Challenge Grants, to provide equipment and support to schools implementing GLOBE.

Providing Teacher Supports and Follow-up

Providing ongoing and sustained follow-up support is recognized as one of the greatest challenges for the franchises. Often, franchise leaders must invent new strategies or incentives to bring teachers back for more training. Sometimes, an effective incentive is to offer teachers professional development course credits (e.g., 1 credit is offered for 5 days of training, as in Los Angeles) that can be accumulated over time and applied toward salary increases. Other franchises use teacher conferences as a portal for follow-up activity. In North Carolina, the franchise coordinator described a plan to have a special meeting at the state science teachers' conference where franchise-trained teachers could assemble for a follow-up activity. However, she felt that there would have to be some incentive for the trained teachers in order to attract significant numbers for refresher training.

A strategy that appears to work with teachers is having trainers call former trainees. Often, the personal phone call to a teacher and an arranged visit to the school help teachers build their confidence in using the protocols. For example, in South Carolina, franchise coordinator Ned Shuler and trainers Teddy Shuler and Norman Rischbieter provide extensive follow-up support activities, not only responding to phone queries but also actively phoning former trainees. They have gone out and helped set up weather stations for teachers who felt tentative, as well as helped to troubleshoot computer and Internet problems. In addition, they urge their teachers to bring their students to the training site for environmental education activities. In this way, the trainers can model teaching approaches in front of the new GLOBE teachers. The South Carolina trainers also provide teachers with new information about the GLOBE Program and tell teachers how to get on the national GLOBE teacher listserv. (They hope to start a local listserv, as well.)

In Alabama, South Carolina, and Los Angeles, the franchises offer makeup days, which can also be used for refresher training. This flexibility on the part of franchises makes it easier for teachers with busy schedules to complete their GLOBE training. At the same time, the fact that franchise training typically occurs close to teachers' homes and that it is often spread out over multiple weeks or even months increases the likelihood that individual teachers will miss some portion of the training. Franchises need to systematically track which of their teachers have completed which GLOBE training units to avoid certifying teachers who have not been trained in all the investigations. Trainers observed at the University of South Carolina franchise devoted significant effort to this task.

Assisting with Technology Access

One of the most challenging problems for franchises is how to support schools where technology access is a problem. The greatest barriers faced by teachers, according to the Alabama franchise coordinator, are technology support, Internet access, and lack of equipment. There is a real problem in Alabama with having computers available for efficient data entry. Because few Alabama teachers and students have access in their classrooms, they must schedule a special time (often weekly rather than daily) to enter GLOBE data. The franchise coordinator is now participating in a statewide effort to help ease this problem over the next few years.

The situation in Alabama is not unusual. Franchises we observed are often restricted in the technology support they can provide to making sure the schools have a GLOBE ID number and doing occasional troubleshooting when a teacher has a connection to the Internet but is experiencing problems entering data into the GLOBE database. Many of these problems stem from teachers' inexperience using the Internet, sometimes compounded by network architectures, Internet service provider unreliability, or details of the interface design. Franchise staff expressed frustration at this continuing problem, faced by a large number of their teachers.

Developing Partnerships

Forming partnerships with other franchises and/or other GLOBE-enhancing programs often requires significant effort on the part of the franchises. In some cases, they use their trainings as opportunities to meet other organizations and programs.

GLOBE in Alabama is a prime example of co-development and resource leveraging. The Alabama franchise developed in parallel with EarthSense, a project developed with funding from NASA's Earth Science Enterprise, Eisenhower grants, and the National Institute for Global Environmental Change, that involves students in "ground truth studies" using remote sensing. Franchise coordinator Greg Cox piloted this new program in north Alabama in 1995. Just after this time, in January 1997, the University of Alabama in Huntsville was named the GLOBE Program franchise for Alabama, and many EarthSense and GLOBE activities were coordinated. Cox has also leveraged relationships with other Alabama institutions to provide in-kind resources for GLOBE. He has formed liaisons with informal learning organizations, including the Huntsville Botanical Gardens and the US Space and Rocket Center, which provide space for training sessions and occasionally sponsor events.

The University of South Carolina is another example of resource leveraging. The environmental education center where the university holds GLOBE training is located on the Department of Energy's Savannah River site (which includes a forest preserve managed by the Forestry Service). The Department of Energy is interested in offering education programs on this site as part of its public outreach. GLOBE franchise activities build on an active environmental education program for students that has been ongoing at the site for some years.

Sometimes, forming a partnership with an organization such as a college or university allows teachers to quickly immerse themselves in several academic and community-based programs. For example, in the Los Angeles franchise, led by John Zavalney and Henry Ortiz (teacher and science facilitator), they immediately formed a relationship with UCLA's Joan Clemons and the university's Center X.

Center X promotes many science and mathematics programs for inner-city teachers and schools and receives funding through the NSF-supported Los Angeles Urban Systemic Initiative. By hosting their trainings at UCLA, the Los Angeles franchise is able to involve departments such as Marine Sciences in training and field trips. In addition, GLOBE activities are coordinated with existing community-oriented programs, such as Tree People or Adopt-A-Watershed.

Getting Scientists on Board

Attracting scientists and sustaining their interest as partners also is difficult but often is easier when franchises partner with institutions where scientists work and conduct their research. The Los Angeles franchise has managed to involve emeritus professors such as Ray Lundt, Emeritus Soil Scientist, who helps them work on their GLOBE in the City program. Specifically, Lundt and some of his graduate students are using Landsat images and looking at local soil distribution profiles in the city. Lundt was eager to collaborate with the GLOBE Program because of his interest in using the GLOBE database. Involving more graduate student scientists might be one way to get more scientists on board while reducing reliance on junior faculty who are typically busy establishing credentials to qualify for tenure.

Gaining Political and Institutional Support

In addition to forming partnerships with scientists and organizations that can play key functions within the GLOBE franchise, franchises have devoted considerable time and effort to gaining political and institutional support for GLOBE in their regions. In Alabama, franchise coordinator Greg Cox has sought support from the state's congressional delegation, state legislature, and the state department of education. He has also worked on the local level with district personnel to ensure their support for GLOBE in districts where he has trained teachers. In Cox's view, district-level staff are the people most able to provide the resources (equipment, teacher time, and mentoring) that make it more likely that teachers will implement GLOBE. He has found that teachers who sign up individually for GLOBE training with little support from their districts have a much harder time implementing GLOBE. Cox encourages districts to support GLOBE implementation in addition to supporting training. This strategy has also been adopted by the franchise in North Carolina, which has worked to convince participants' schools to provide $100 toward the purchase of equipment for the participating teacher.

Discussion

Of the 95 organizations that had signed franchise partnership agreements with GLOBE by June 1999, 60 organizations trained teachers during 1998-99. The franchises that have been able to mount and sustain active programs are those with sufficient preexisting infrastructure to support teacher recruitment and training, the leadership to form partnerships and find multiple funding sources, and a zeal for providing teacher follow-up and support activities. The evolving network of franchise coordinators and trainers will be an important source of inspiration and new ideas as this part of the GLOBE Program continues to grow and evolve.

Chapter 7. GLOBE International Partners

The participation of countries from around the world has been an integral part of the GLOBE concept from the very beginning. Scientists, educators, and heads of states worldwide have been actively encouraged to bring their countries' schools into the GLOBE Program. In April 1994, Vice President Al Gore announced the GLOBE initiative and invited the countries of the world to participate. In November 1994, educators from many countries met in Washington, D.C., to discuss the development of the educational materials to be used with the GLOBE science protocols, to solicit input and comments on the materials, and to review environmental education materials used in their countries for possible inclusion in the GLOBE materials

Internationally, GLOBE is managed as a cooperative science and education program Partners have the flexibility in choosing how to manage the program and what aspects to emphasize. Bilateral agreements, or memoranda of understanding (MOUs), specify the respective roles and responsibilities of the U.S. GLOBE Program and its international partners. The GLOBE Program provides the general program infrastructure while each country manages its own implementation independently. Like the U.S. franchises described in Chapter 6, each international partner hires its own Country Coordinator, selects the participating schools, and recruits and trains its own teachers.[1] International partners also identify their own funding resources, equip their schools, and provide the supports necessary to sustain their implementation. GLOBE is funded entirely by each international partner, with no exchange of funds. The only requirement is that participating schools in each country conduct the measurements in accordance with the GLOBE data collection protocols and use equipment that meets GLOBE specifications under the supervision of teachers trained by GLOBE trainers.

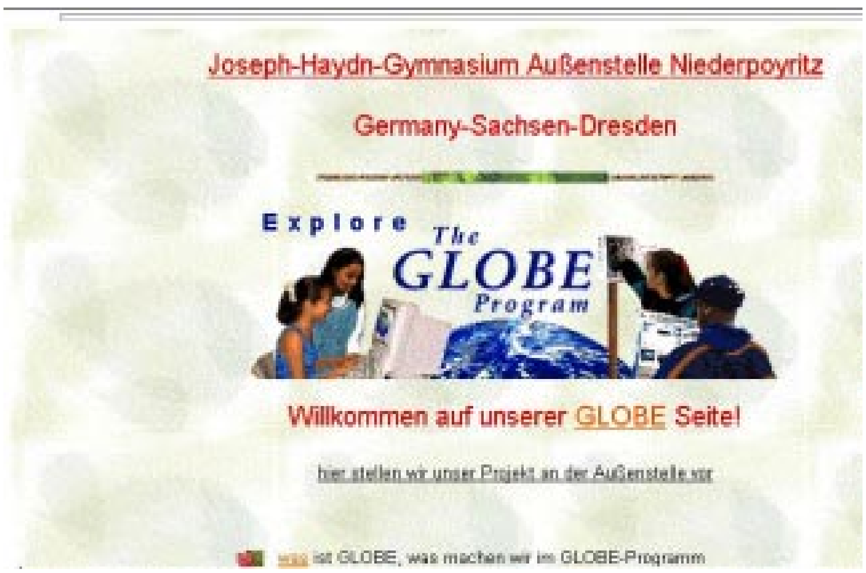
Scope of Participation

The scope of international participation has been significant since the GLOBE Program's genesis. International workshops for Country Coordinators were held in four locations around the world during the summer and fall of 1995. The Country Coordinators then established their own teacher training programs. In the spring of 1995,

[1] The success of the international partner model, in fact, was the inspiration for launching U.S. GLOBE franchises.

21 countries had signed MOUs to participate in GLOBE. By the end of the 1995-96 academic year, more than 230 international teachers had been trained, and 173 schools from 19 countries outside the United States were contributing data (Means, Coleman, & Lewis, 1998). By June 1999, more than 2,000 educators outside the United States had been trained, and schools in 84 countries were participating in the program. Many of the measurement protocols and data-reporting forms have been translated into the six United Nations languages. Over a dozen countries, speaking languages beyond these six, have translated GLOBE materials into their own languages. Many countries, however, choose to use GLOBE as a means to promote greater proficiency in English among their students.

Exhibit 7.1
GLOBE Web Site for a German School



GLOBE international partners have implemented the program in a variety of ways. In this chapter, we examine some of the common and contrasting features of GLOBE implementation among the international partners, based on write-in responses from the Partner Survey and on interviews with Country Coordinators attending GLOBE annual meetings.

Sponsoring Agencies and Coordination

Typically, the primary sponsoring agency for GLOBE is the country's Ministry of Education or Ministry of the Environment. The sponsoring agencies' role is to provide funding for GLOBE and to manage the implementation of the program within their country. In some countries, a consortium of agencies sponsor GLOBE and work with the country's provinces or territories that choose to participate.

In many cases, a sponsoring agency contracts with an outside organization to implement GLOBE. Typically, these organizations, generally universities or nongovernment organizations (NGOs), take responsibility for implementing GLOBE and working with schools and teachers within the country. In this way, countries can take advantage of existing relationships between the NGO or university and country schools. In Australia, for example, CSIRO coordinates GLOBE activities. In Argentina and Greece, the Country Coordinators are university professors, and their universities coordinate the implementation of GLOBE in those countries. In Costa Rica, a group of private foundations coordinated by the Costa Rican Ministry of Education manage GLOBE's implementation. In the Netherlands, the Dutch Institute for Environmental Communication provides technical assistance for GLOBE implementation and helps to coordinate collaborative projects with different international schools. In the United Kingdom, the Wildlife Trusts, in partnership with a number of nongovernment organizations, is responsible for implementing GLOBE.

External Partners Supporting GLOBE

Increasingly sophisticated public-private partnerships are emerging among international partner countries in support of GLOBE activities. External partners play an increasingly important role in supporting GLOBE implementation internationally. Private-sector commercial firms are contributing financial and logistical support to supplement the MOEs' support of GLOBE. Universities and university-based research institutes are also having an influence on training activities and the linkages between students and scientists. A host of bilateral and multilateral organizations have contributed significantly to a wide range of GLOBE activities, especially in developing countries. The World Bank, the British Council, the U.S. Information Service (USIS), the U.S. Peace Corps, the United Nations, and the U.S. Agency for International Development (USAID) are among the many agencies that support GLOBE activities in a number of countries. In Benin, for example, USAID and the United Nations High Commissioner for Refugees provide funding and logistical support to GLOBE, and the Peace Corps has been actively involved in teacher professional development activities. Funding from the World Bank has supported GLOBE activities in Madagascar. The U.S.

Embassy, along with USIS, the U.S. educational and cultural organization, has played an important role in supporting GLOBE in Egypt and Senegal.

Exhibit 7.2
USAID Support of GLOBE in Jordan

Program Guiding Visions

GLOBEhas three over-arching goals:

- to enhance the environmental awareness of individuals worldwide,
- to increase scientific understanding of the Earth, and
- to improve achievement in science and mathematics education.

Within this framework, each of the partners within the United States and internationally applies its own interpretation and emphasis, reflecting local circumstances and priorities. A number of partners emphasize environmental awareness at local, regional, and global scales. GLOBE participation and activities in these countries are motivated, sometimes overtly but often more subtly, by a strong sense of social responsibility and a commitment to protecting the environment. One Country Coordinator describes it this way: "GLOBE provides an extended environmental acquaintance, creates consciousness in relation to environmental problems, and generates joint responsibility for the future of global development…"

Some Country Coordinators express the belief that the program has to have some social relevance beyond academic learning (such opinions exist also among some U.S. GLOBE teachers and franchise staff). The following excerpts from an interview and the survey illustrate this point:

> *"Because of its global implications, and its social relevance, GLOBE will easily fit into [country X's] curriculum. Many people mistakenly see GLOBE as only a measurement program. We have to convince people in [country X] that it is more than taking measurements; that it has social relevance and application. We know that GLOBE in the U.S. frames things in terms of natural science. We have to go beyond that in [country X] to include the social context of environmental education…"*
>
> *"The long term benefit [of GLOBE] is teaching students about the interconnections between many/all environmental living and non-living variables that can affect the environment…"*

Advantages of relating GLOBE to environmental concerns were documented in Germany. In interviews with teachers at 15 German GLOBE schools, Professors Hansjorg Seybold and Dietmar Bolscho (1999) found that schools engaged in environmental projects had a stronger positive attitude toward GLOBE and did more collection of GLOBE data.

Although not articulated as a program goal, an important underlying value or philosophy is the importance of international collaboration and cultural understanding. With the advent of collaborative distance learning activities among a number of schools on different continents, international collaboration and understanding are being viewed by many participants as important goals or outcomes of GLOBE. International collaboration is seen both as an important means to an end and as a goal in its own right. In many cases, international collaboration is viewed as a strategy for stimulating greater in-country interest in GLOBE or as a means of national self-expression. In listing the benefits of participating in GLOBE, one survey respondent noted, "…opportunity to learn about other countries, other cultures; my country is known by other parts of the world."

One of the benefits of collaborative project-based activities among multiple GLOBE international partners is the increased likelihood of developing ties with other countries and promoting scientific and cultural exchange among the participants. This value or vision of international collaboration and cultural understanding appears to be a powerful driver for GLOBE participation in many countries:

> *"The GLOBE Program has risen in all participants the true sense of the 'global village'. It's an excellent way to feel all the links that connect peoples and nations all over the world, from a very early age."*

GLOBE international collaboration also allows countries to link local environmental issues with global conditions elsewhere. The desired intellectual appreciation of the linkage between local environments and global systems can be supported by participation in international investigations.

> *"We want the program to be sustainable in the long run. Change is typically slow, especially when you are raising awareness and dealing with values. We want students to develop a large view of the environment and how their choices affect things globally. We also want to develop ties with others in our region. There are possibilities for cultural exchange now that the Cold War is over…"*

> *"GLOBE will be more appealing when it becomes more relevant to the local area – 'How clean and healthy is my river/atmosphere/soil/plants and animal life?' and 'What can I do about it?' and 'How does this compare with other sites here in my region and overseas?'"*

Another program goal stated by a number of Country Coordinators is the stimulation of the use of instructional technology within their country's schools:

> *"The GLOBE Program is a great tool for the schools to fulfill the goals in environmental education/science education, use of IT, [and] internationalisation."*

Exhibit 7.3
Collaboration between GLOBE Schools

Recruitment and Enrollment of Schools

International partners employ a variety of models to recruit schools for participation in GLOBE. A common approach is for a country's sponsoring agency to choose a number of pilot schools representing different regions of the country to implement the program for a certain period of time. These pilot schools typically are selected because they have the necessary infrastructure and are located in an area where GLOBE activities can be conducted with relative ease (e.g., near a freshwater source, a forested area, etc.). In another model, schools become part of GLOBE through a structured application process whereby they are judged against certain criteria and then selected. In a small number of countries, participation in GLOBE is open to any school that has the capacity to participate without government assistance. This approach is more common in countries where participation in GLOBE is limited to private schools (as in Turkey) or to private English language schools (as in Pakistan).

Schools (rather than individual teachers or school districts) are the primary targets for GLOBE recruitment among international partners (see Table 5.1 in Chapter 5). GLOBE schools in partner countries generally have more requirements to meet in order to enroll as a GLOBE school than do schools in the United States (see Table 5.2 in Chapter 5).

Implementation Setting

Internationally, GLOBE is implemented in a variety of settings within schools. Implementation can occur either during class time or as an outside-of-class activity. Implementation of GLOBE during the class period is occurring in a number of countries, such as Denmark, Finland, Norway, and the United Kingdom. Outside-of-class GLOBE activities typically are conducted in independent study groups or extracurricular science clubs. Although there are notable exceptions, this outside-of-class implementation of GLOBE is generally present in countries where the national curriculum requirements limit the number of additional activities teachers are able to introduce within the school day. In these cases, GLOBE is not integrated into the regular school curriculum. For example, in Japan and Benin, although plans are being discussed to integrate GLOBE activities into the curriculum in 2002, GLOBE protocols are conducted outside of the regular class period. In Greece, Russia, and Egypt, GLOBE activities generally take place after school, outside of class time. In some cases, GLOBE is introduced to students as an in-class activity, and, as students become more familiar with the science protocols, they transition to collecting data independently during non-class-time periods. This pattern of implementation is present in GLOBE schools in the Netherlands and in Madagascar, where GLOBE activities begin during class time and continue outside of the regular class period.

International Partner Strategies

Data from the Partner Survey and interviews with the Country Coordinators suggest that GLOBE international partners face a set of challenges as they implement and expand their scope of activities in their countries (see Chapter 4). Some of the strategies countries are developing to deal with those challenges are described below.

Obtaining Funding

The lack of funding to purchase equipment is the most frequently mentioned challenge facing GLOBE international partners. More than 50% of the international respondents to the Partner Survey cited fund-raising as a major challenge (see Table 5.9 in Chapter 5). This is a challenge that countries face regardless of geographic location. Tight government budgets leave the program vulnerable to budget fluctuations. As one Country Coordinator put it, “The biggest challenge is to keep GLOBE afloat in spite of the absolute necessity of pinch and scrape after another and yet another of the exorbitant governmental cost-cutting axes…”

Since most of the funding of GLOBE comes from the public sector, GLOBE partners are dependent on annual allocations of government funds to support their activities. In light of dwindling budgets in many countries, funding shortfalls appear to be a common phenomenon, especially for newly implemented programs. In some countries, GLOBE is treated as a pilot program, increasing its vulnerability when education resources are cut. In countries where there is joint sponsorship of GLOBE (e.g., by the MOE and the Ministry of Environment), GLOBE is less dependent on the level of funding received by a single agency.

In the face of budget shortfalls, many GLOBE international partners organize and engage in fund-raising activities to sustain their programs. Typically, the private sector is the target of these fund-raising efforts. Commercial firms, banks, entrepreneurs, and philanthropic organizations are among the sources of supplemental financial support for GLOBE in a number of countries.

Some countries are receiving nonfinancial support from external partners. This support can be the provision of personnel, in-kind services, or equipment. International partners in the Netherlands, Benin, and the Czech Republic, for example, have sought out private banks and firms for donations to support GLOBE in their countries.

Aligning GLOBE with National Curricula and Goals

A commonly cited challenge described by the international partners is the lack of congruence between GLOBE activities and the national curriculum requirements. In addition to the common difficulty of teachers’ perception that they do not have enough time to fit GLOBE into their class schedule, there exists, in a number of countries, a broader conflict between GLOBE content and national curricular goals. This dissonance between GLOBE and the schools' curricula provides an additional barrier to implementation and may explain, in part, why international GLOBE teachers are more likely than U.S. teachers to implement GLOBE outside of regular class periods or in the context of an extracurricular science club. (See Table 4.1 of Means, Coleman, & Lewis, 1998.)

> *"Major difficulties, pointed out by the teachers, concern the present educational system – national curricula, national exams, overloaded schools, time schedule, coordination obstacles within each school."*

Country coordinators report that the lack of curriculum integration is being addressed primarily through direct negotiations between the Country Coordinator and the curriculum and assessment specialists in the Ministry of Education. These discussions are taking place in a number of countries to coordinate ongoing reform efforts with the introduction of GLOBE. In a number of countries that have experienced educational decentralization, the integration of GLOBE into the curriculum is beginning to occur. In a few countries, the task of aligning GLOBE with the national curriculum is a daunting one. One Country Coordinator reported, "There isn't much to do in terms of changing the curriculum because it is a centralized process. It will take a very long time to see change occur there…" The process of aligning GLOBE instructional activities with the national curriculum appears to be at varying levels among international partner countries. The integration of GLOBE into the goals and curriculum of each country will have important implications for long-term sustainability of the program.

Teacher Supports

Another challenge to GLOBE implementation in any country is the general resistance to change. Whether the resistance is active or more a matter of passive inertia, several Country Coordinators cited this as a significant barrier. In some countries, the perceived resistance comes from school administrators who are interested in maintaining the status quo. According to one GLOBE coordinator, "…in [our system], everything is top-down and GLOBE is a bottom-up kind of program. There is some conflict between our system and there is resistance [to GLOBE]…" Nonsupportive administrators can make things difficult for teachers who are trying to gain confidence in implementing a challenging, hands-on science program.

Some Country Coordinators reported that teachers in their countries are uncomfortable with the classroom management challenges that hands-on activities bring to the instructional setting. Some teachers have difficulty overcoming the fear of losing control of their class; others are afraid of using new technologies. Some teachers are the only ones implementing GLOBE in their school and worry about a lack of support from their colleagues.

A variety of strategies are being employed to support GLOBE teachers in GLOBE partner countries. Teacher supports, ranging from refresher courses for new trainees to pairing teachers from different schools, were the most commonly cited by Country Coordinators. In Costa Rica, for example, GLOBE schools are paired with science institutions to develop a support model with a GLOBE teacher working with a scientist from the scientific institution, who may design additional protocols to fit a local research agenda. A science coordinator who visits the GLOBE schools regularly monitors the pairs' activities. In addition to promoting greater interaction among scientists, teachers, and students, this model seeks to make GLOBE directly relevant to the local setting.

Another strategy employed by several GLOBE Program offices is to actively reach out to teachers and administrators through a variety of group meetings. These outreach efforts are focused on clarifying the aims of the GLOBE Program and discussing how implementation can be facilitated at an administrator's or teacher's school. An overnight conference or meeting, according to one Country Coordinator, "…broadens their [teachers'] minds and gives them new ideas and energy…" The Czech Republic instituted conferences where GLOBE teachers can exchange reflections on their experience implementing GLOBE and share strategies for integrating GLOBE into their schools and raising needed funds (see Exhibit 7.4). GLOBE in Croatia has made an effort to involve school administrators in GLOBE so that they will have a better understanding of the program and be more likely to support it. In November 1998, Croatia's Country Coordinator, Diana Garasic, held a conference for principals from 41 Croatian GLOBE schools. In addition to discussing the ideas behind GLOBE, the school administrators had the opportunity to try out GLOBE activities, both outdoors and in the laboratory. The administrators also discussed the principal's role in GLOBE and issues of common concern, such as managing the costs of Internet connections. Meetings with colleagues can renew commitment and provide an exchange of ideas for administrators as well as teachers involved in GLOBE.

Exhibit 7.4
Invitation to Czech Republic GLOBE Teacher Conference

I. INTRODUCTION

The GLOBE Program

GLOBAL LEARNING AND OBSERVATIONS TO BENEFIT THE ENVIRONMENT
GLOBE is worldwide science and educational program coordinating the work of students, teachers, and scientists to study and understand the global environment.

The GLOBE Goals:
- increase environmental awareness of individuals throughout the world,
- contribute to scientific understanding of the Earth,
- help students reach higher standards in science and mathematics.

Dear Friends,
We would like to inform you about the course and results of the First Czech Evaluation Conference on the GLOBE International Program which took place on November 28, - December 1, 1996 in Celákovice, the Czech Republic. It was organized by TEREZA, the Association for Environmental Education, which a GLOBE coordinator in the Czech Republic, and US Peace Corps, which provide assistance from the very beginning of the GLOBE program. The GLOBE program was initiated by Mr. Al Gore, US vice-president, in 1994. One year later, when the 25th anniversary of the Earth Day was celebrated, the GLOBE program had its opening ceremony on the international level, including the Czech Republic. During one year and a half, the GLOBE program has bee developed very well and 72 Czech groups have joined it. In the GOBE Center in the United States, further development of the project went on and new measurements (GLOBE II) were prepared which may gradually enrich the existing GLOBE I program.

First of all, it was necessary to evaluate the work of the children, students, teachers or groups leaders participating in GLOBE I. This is why we decided to organize the First Czech GLOBE Conference to which we invited GLOBE participants in the Czech Republic, Peace Corps volunteers who help with the program at the individual schools, representatives of the Ministry of Education, Ministry of the Environment, American Embassy and GLOBE Scientific Board.

The Conference had two main spheres to discuss, First it was evaluation of the course of the GLOBE project until now, through TEREZA and the individual GLOBE schools representatives, exchange of experience, the question of including the project into a school life, prospective of the GLOBE program in the next years, and cooperation with Peace Corps volunteers. Another great topic was fundraising and trainings aimed at fundraising for the GLOBE project by the individual schools or groups.

Each representative of a GLOBE school who took part in the Conference informed all the dear guests and other GLOBE participants about how the project is implemented in his or her school. Each group representative brought with him or her materials to give a presentation of the school (group) as well as a poster on the GLOBE program in the respective school.

We would like to express our thanks to Mr. Pavel Sremer of Peace Corps who helped with preparations of the seminar and also ensured necessary funds thanks to Peace Corps organizations.

The last pages are dedicated to development of the GLOBE program in the Czech Republic, as well as its possibilities for the future.

With best wishes from TEREZA

Dana Votápková

Jana Ledvinová

Many countries produce their own GLOBE newsletters, as exemplified by the excerpt of one of GLOBE Australia's newsletters in Exhibit 7.5. A number of Country Coordinators described their efforts to translate GLOBE materials into the local language so that teachers could easily understand them. In some countries, the coordinators have put together brief, easy-to-use teacher's guides that complement the larger, more comprehensive GLOBE Teacher's Guide. One Country Coordinator reports that this concise guidebook has helped teachers immensely to be able to plan and to access information far quicker than with the larger notebook. Another Country Coordinator describes how "We have incorporated a number of GLOBE teachers on our NGO board of directors to give more motivation to school teachers and to make them feel more responsible."

The Growing Significance of International Collaborative Projects

International partners reported that one of the many benefits of their GLOBE participation was the increased contact and collaboration with other GLOBE partners throughout the world. Twenty of the 43 international Partner Survey respondents cited increased contact and interaction with other GLOBE schools in different countries as one of the benefits of participating in the GLOBE Program. This sentiment emerged clearly over the range of interviews conducted with the Country Coordinators, as well. The following excerpts from the survey responses illustrate this emerging perception of the benefits of GLOBE participation:

> *"The program arouses global awareness among the students and presents the feeling of being an active part of an important international community…"*
>
> *"Meeting very interesting people from foreign countries and also from our country…"*
>
> *"Promotes good inter-country relationship and provides knowledge of environmental behavior of the countries…"*
>
> *"It is a very fascinating program, which definitely connects people around the world…"*

These comments reflect the growing sense that international partners view GLOBE as an international community of learners.

Exhibit 7.5
Excerpt from GLOBE Australia Newsletter

GLOBE AUSTRALIA NEWS

Number 9 – October 1996

To the GLOBE Lead Teacher

Australian GLOBE Stars—School of the Month

The number of schools reporting data on a regular basis is increasing. Keep up the good work.

We would like to congratulate:

Presbyterian Ladies' College - WA

for their outstanding data reporting record this month.

We would also like to congratulate:

Carine Senior High School - WA

for their data entry and for their development of a fantastic GLOBE Web page. The URL for the Carine Senior High School Home Page can be found under "Cool Sites of the Month". Well done to both schools! A certificate will follow shortly.

Hands-On GLOBE Activity

On the 18th of this month, an email was sent to draw your attention to a new addition to the GLOBE Visualisation Server. To find this new addition, look under "What's New." There, you will find student contour maps and satellite reference images of Hurricane Fran.

This site is definitely worth a look. Not only are there some spectacular images of the hurricane itself, but GLOBE has provided information and student contour maps to help GLOBE students understand the effects caused by a hurricane. (Up to 200 mm of rainfall was measured on Sept. 6)

There is even a student question:
More evaporation usually occurs when weather is dry and sunny. So, why is there a maximum of evaporation under the hurricane, where the weather is cloudy and rainy? And, on the September 6 image, why does evaporation decrease as the hurricane moves over land?

Exhibit 7.5
Excerpt from GLOBE Australia Newsletter (Continued)

GPS Unit and Satellite Images Update

When you receive the GLOBE GPS unit and measure your school coordinates, could you please send the data record sheet back to Julia as soon as possible. Please include on the sheet whether you would like your image on an IBM or Macintosh disk.

GLOBE Australia is distributing a media release connected with GLOBE Australia biometry sites, satellite images and GPS co-ordinates. Please be aware that the contact details for each GLOBE school has been supplied. If you are approached by newspapers, television or radio stations to discuss your school's site, GLOBE Australia would appreciate your co-operation in helping the media learn more about the GLOBE Project.

Data Entry Week – Reminder

Don't Forget! Monday 21 - Friday 25 October is the next *GLOBE Data Entry Week* where all schools will make an extra effort to record and enter data. Both Atmospheric (air temp, rainfall, cloud cover) and Hydrology (water temperature and pH) measurements are to be recorded.

Incidentally, October 21 - 25 is also *National Water Week*. Why not make the most of this week and utlilise GLOBE Hydrology measurements as a means of increasing your schools awareness of water monitoring.

We will send out the data record sheet in the next GLOBE News so you can check out your state's/territory's progress. The visualisations should also be spectacular, so it may be a good idea to run one of the GLOBE student activities to utilise this data

Remember, if you require any help, contact Julia or another school in your state/territory.

Cool Sites of the Month

ERIN has recommended the following Web sites. These may help in explaining the interrelationships between the three GLOBE research sites. The Bureau of Meteorology and El Nino sites can be used to supplement Keith Colls's workshop paper on "Linking the Research Sites".

You can access these sites easily by visiting "Cool Sites of the Month" on the GLOBE Australia Home Page.

- World Climate of the Twentieth Century
- Waterwatch Victoria - Great site to look at during "Water Week"
- Bureau of Meteorology Web Southern Oscillation Index (SOI)
- Predications of E1 Nino/Southern Oscillation
- An agricultural focus on E1 Nino/Southern Oscillation predications

Teacher Listserve

At the suggestion of many GLOBE teachers around the world, an email list has been created to foster communication among GLOBE teachers. This tool will be solely for the use of teachers wishing to share experiences, ideas, challenges, opportunities and other issues you feel are important. We hope that this new tool will enrich the Program and facilitate the creation of networks among GLOBE teachers worldwide.

Collaboration among GLOBE international partners has been catalyzed as a result of the contact GLOBE has provided for many of the partners. A range of projects that have been conducted among multiple participating countries have yielded scientific and educational benefits, as well as stronger ties and relationships. Below we describe some of the GLOBE international activities that promote collaboration.

GLOBE Learning Expedition

Conducted in Helsinki, Finland, in the summer of 1998, the GLOBE Learning Expedition featured teams of GLOBE teachers and students from different countries who met face-to-face to learn from each other and to share the results of their respective countries' GLOBE projects. It was the first time in the history of GLOBE that such a wide range of participants were able to meet to discuss GLOBE activities. The event also included an overnight camping trip, Web chats, and virtual presentations from other GLOBE students using the Internet. A total of 24 countries participated in the GLOBE Learning Expedition.

Regional Collaboration

Regional collaborative learning projects are developing among GLOBE partners in a number of GLOBE countries. These collaborative arrangements generally have been sparked by the initiative of the Country Coordinators. Norway and the Czech Republic, for example, have coordinated a project between seven pairs of schools in each country. Their project consists of using archives of Atmosphere and Hydrology data to study the similarities and differences in their respective countries. At the conclusion of the 1998-99 academic year, teachers and headmasters from the seven pairs of schools met in Prague to give presentations and discuss their activities. Next year, the two countries will engage in competitive activities pairing different schools from each country. Additionally, Spain will link with Norway to conduct collaborative distance learning projects between schools in the two countries next year.

A partnership between GLOBE students in South Africa and Finland has touched off a joint project in which a secondary school in each country will study their respective environments. In addition to being able to exchange and share data, this partnership has fostered strong links between the two schools.

Exhibit 7.6
GLOBE Learning Expedition Web Site

A larger, regional partnership is emerging among a group of European GLOBE partners who have banded together to promote collaborative activities, seek funding for those joint activities, and request formal recognition from the European Union as a European GLOBE organization that will encourage the participation of other European countries in GLOBE. Although this effort is still in its early stages, this development presages the emergence of a variety of regional structures that could support regional cooperation and foster the expansion of GLOBE.

School-to-School Activities

One of the innovations that resulted from the Helsinki Learning Expedition was the expansion of the GLOBE Web site to include a new area called School-to-School Activities. This portion of the Web site allows GLOBE students and teachers to identify partners for a variety of research studies, as well as to display information about what the schools are doing and how a school can join an ongoing project. One of the school-to-school activities involves schools from Norway, Germany, and California sharing Atmosphere data and information about how winter is experienced in each country. In another project, Greek GLOBE students invited schools from around the world to compare their GLOBE data with data collected by local meteorologists and to discuss their findings. Ongoing activities involve the study of lilacs in Germany and water quality and sustainable development around the world.

Discussion

GLOBE participation internationally reflects the diversity of a variety of implementation models, adapted for each partner country's needs. Previous research examining cross-national diffusion of educational change would suggest that such diversity is healthy (Dalin, 1973). Organizations or institutions do not simply adopt an innovation wholesale; rather, they adapt it in ways that suit their and their sponsors' needs. They use resources within and outside of the institution to accomplish this adaptation. Rarely does an institution accept an innovation from the outside without having the innovation go through some form of metamorphosis. Dalin (1978, 1983) proposes a model for analyzing an institution's capacity for adaptation that is related to the institution's creativity, that is, "the ability of an institution to identify its own development needs and to organize a process of self-renewal..." (Dalin, 1983, p. 97).

GLOBE was designed to be flexible enough to permit implementation under a wide range of circumstances. Reports from the Country Coordinators suggest that GLOBE is, in fact, flexible enough that it can be adapted to local or national settings and constraints, while maintaining the level of uniformity necessary to achieve its scientific goals. Increasingly, international partner countries are leveraging local resources in creative ways to expand participation and to engage in collaborative project activities across national boundaries. Program philosophies in a number of countries link GLOBE's scientific and academic objectives with local and global environmental concerns. The challenges facing the international partner countries are similar to those reported by teachers and Franchise Coordinators in the United States. Each partner is developing a suite of strategies to build and sustain its program. International collaboration is emerging as a major benefit for many GLOBE partners. All of these trends suggest that an international GLOBE scientific and educational community is starting to emerge.

Chapter 8. Web-Based Student Assessment

Through their participation in GLOBE, students have opportunities to collect and examine data about the atmosphere, water, soils, land cover, and changes in seasons in their area. Students' activities contribute to science, as researchers use GLOBE data to test models and hypotheses and to verify information about the environment collected by satellites. At the same time, students' GLOBE activities can contribute to their own developing understanding of the Earth as a system of interdependent and interconnected adaptive elements and cycles and to their skill in analyzing environmental data to solve scientific and other real-world problems.

As part of this year's GLOBE evaluation, we set out to assess the feasibility of using a Web-based assessment environment to measure students' environmental awareness and data analysis skills. In the Web-based assessment environment we designed, our aim was to provide a set of problems that would require students to use the concepts they encounter in collecting and analyzing GLOBE data. We anticipated that greater exposure to GLOBE would contribute to a better understanding of the environment as an ecological whole and to greater skill in using data to reason and make decisions about a real-world problem.

The kind of assessment environment we built for GLOBE is similar to assessment tools that other researchers have devised in recent years to measure such higher-order thinking skills as planning, collaboration, problem solving, and decision-making (Blum & Arter, 1996; Darling-Hammond, Ancess, & Falk, 1995; Perrone, 1991). These new assessments often require students to perform complex tasks that demonstrate student skills in interpretation, model building, analysis, and synthesis to solve an open-ended or ill-structured problem. In this respect, these new assessment tools present students with the same kinds of problems that scientists and scholars in other disciplines face in their own research (Dunbar, 1996; Lawless & Rock, 1998).

Across the disciplines, a number of standards that reflect the kinds of higher-level thinking skills that students should be expected to master have been articulated (see, for example, National Council for Geographic Education, 1994; National Research Council, 1996). In the natural sciences, researchers have emphasized the importance of helping students learn how to *talk science* (Lemke, 1995). This term refers to the use of scientific discourse to explore phenomena, interpret the world around them, and develop explanations for natural events. Talking science is not only a *goal* of learning; it is also believed to be a *vehicle* for developing student understanding (Miller, 1987). By supporting students' inquiry and negotiation, students' involvement in talking science may help them develop a view of science learning as "science-in-the-making" rather than as "ready-made science" (Latour, 1987). In particular, having students formulate and discuss explanations of phenomena has been found to be a particularly powerful aid in learning because the process of developing an explanation helps develop students' understanding about why problems are posed the way they are and helps to clarify to students what needs to be explained (Chi, deLeeuw, Chiu, & LaVancher, 1994; Coleman, Brown & Rivkin, 1997; Coleman, 1998; Ohlsson, 1992; Webb, 1989) or reconciled (Gobert & Clement, 1999; Linn, Bell, & Hsi, 1998).

Over the last two decades, the way that scientists themselves represent information and communicate with colleagues has been transformed by new visualization, modeling, and network technology (Pea, 1994). It is appropriate, therefore, to incorporate technology tools and supports into both the teaching of science and the assessment of science learning. Technology-based assessments of science learning are just now emerging. The best known are the assessments embedded in an on-line environment for acquiring skills in scientific problem solving recently developed and implemented at Vanderbilt University (see Cognition & Technology Group, 1997). An application in the area of environmental science is a Web-based assessment that analyzes students' concept maps of the domain before and after a search of the World Wide Web (Schacter et al., 1997). Although similar in approach to our design for GLOBE assessment tools, none of these assessments focuses on students' ability to engage in science discourse. Moreover, the feasibility of using Web-based assessment environments to evaluate large-scale interventions and programs is largely untested. Ultimately, assessments of student skill in using science talk to support data analysis and problem solving could provide evaluations with more meaningful alternatives than the norm-referenced tests that are so widely used by districts and states.

In the on-line assessment environment we piloted, small groups of students performed two complex tasks. First, in the Environmental Awareness task, they described features of the environment they saw in a color image of the Mount Hood (Oregon) region. Second, in the Olympic task, students were asked to solve a real-world problem involving the use of climate data and to present an argument justifying their solution to the problem.

We believe that this year's pilot of this Web-based assessment confirms the viability of using a technology-based method for measuring student environmental awareness and data analysis. Moreover, our pilot findings suggest that participation in GLOBE can have a positive effect on students' scientific understanding of the environment. In this chapter, we discuss in greater detail the design of the pilot assessment environment and then report the results from its two components (the Environmental Awareness task and the Olympic task). Finally, we discuss some of the implications of the pilot study and outline future plans for refining the assessment environment for broader implementation in Year 5.

Design Criteria for the Assessment Environment

In developing the Web-based assessment for the GLOBE evaluation, we built six primary design features into the environment. First, the assessment needed to be able to measure the cognitive benefits to students of participation in the GLOBE Program. In other words, the assessment environment and research design had to be capable of indicating whether the GLOBE Program is effective. Second, the assessment had to be accessible to remote sites where researchers could not be present. Third, the assessment needed to be standards based, that is, aligned with middle and high school science, mathematics, and geography standards. Fourth, the assessment was to incorporate the "big ideas" of environmental science, requiring students to demonstrate their understanding of the water cycle, interdependence, and adaptation. Fifth, we wanted the assessment to measure student data analysis in the context of solving a real-world problem. Finally, the assessment was designed to allow students to create dynamic representations of data (e.g., graphs, charts) on-line, to help in their problem solving.

Sample and Recruitment

For the pilot research, we selected classrooms on the basis of their level of contribution of Atmosphere data. We examined the GLOBE database and identified a random sample of 20 middle and high schools across the United States that had submitted more than one standard deviation above the average number of air temperature and rain precipitation measurements between September 1998 and March 1999. We then identified a sample of 20 middle and high schools that were part of the GLOBE Program but that had reported only a few Atmosphere measurements during that same period. By contrasting the two sets of classrooms, we could ascertain whether our assessments are sensitive to different levels of exposure to GLOBE activities.

We recruited teachers from these 40 schools through e-mail, telephone, or mail. An initial interview with teachers was conducted by telephone to inform them of the nature of the task and to make sure that their schools had the necessary equipment. The assessment could run on either a Macintosh or Windows operating system, but a minimum of 16 MB RAM was needed for each computer that students would use to complete the tasks. The computer screens needed to have 256 colors or more to be able to distinguish elements in the images presented within the assessment. Finally, computers needed an Internet connection with Internet Explorer or Netscape (version 3.0 or higher). During this interview, SRI researchers also asked teachers about the extent of GLOBE implementation and their students' exposure to the concepts being assessed in the on-line tasks.

Time required to cope with technical difficulties delayed field testing until late spring 1999. A large number of schools we approached initially were not able to participate. By the time technical problems were resolved, many schools were in the midst of examinations or end-of-year activities. We were able to get data from seven classes, however, which proved adequate for pilot testing. The experience and Web site refinement we gained by implementing the pilot this year will prevent future problems of this sort next year.

The Environmental Awareness Task

One of the central goals of GLOBE is to promote students' environmental awareness, defined as a scientifically informed perception and recognition of the environment as a coherent set of interdependent and interconnected adaptive elements. One way we have investigated environmental awareness is to compare patterns in the environment as described by GLOBE students with those described by non-GLOBE students (see Means, Coleman, & Lewis, 1998). By presenting students with an image of the environment and asking them a series of open-ended questions about the image, we have sought in our Year 3 evaluation and again this year to find evidence that students in classrooms that have implemented GLOBE protocols extensively hold an integrated Earth systems understanding of environmental science.

In Year 3, the task was administered in person by an SRI researcher, who recorded students' initial responses and then probed further with follow-up questions to ascertain whether students were aware of relationships they had not mentioned in their initial descriptions. This year, we attempted to deliver the same task, including a graded series of prompts, over the World Wide Web. Students viewed a picture of Mt. Hood (see Exhibit 8.1) and were instructed to type in a description of the Mt. Hood environment. After doing so, they viewed a second screen, which showed the same picture and prompted them to consider how the water cycle shapes the environment they see. Students were then asked to describe their understanding of how mountains affect the climate of regions such as the one around Mt. Hood.

Environmental Inferences

We analyzed students' responses for instances of "environmental" inferences, that is, statements that included any interpretive reference about the environmental scene (e.g., "those trees must be evergreen"). All of the students' text was divided into idea statements. Each idea statement was coded as a simple description, lower-level inference, or higher-level environmental inference.

Exhibit 8.1
Image of Mount Hood (Oregon, USA)

Descriptions were statements about features that are overtly visible in the scene. These statements lacked any reference to key underlying ecological ideas or causal relationships. For instance, when asked to identify elements and relationships between elements found in the image, many students referred to basic ideas about object, color, shape, or similarity to other places. These student responses are typical descriptive statements:

> *"There is a running river, a tall mountain, and a clear sky."*
>
> *"There is snow on the mountain, and you can see a possible riverbed coming down from it."*

Lower-level inferences referred to things that could be inferred from the picture but that do not explicitly invoke concepts from environmental science. Lower-level inferences may be made on the basis of students' own personal experience or from their study of science. What makes them "lower-level" in our coding scheme is that they do not require students to have an understanding of the Earth as a system. They do go beyond what is evident from the image itself and engage students' interpretive activity, but do not demonstrate a causal understanding of the underlying mechanisms that environmental scientists consider most important:

> *"The mountain must be at a high elevation."*
>
> *"The river must be cold, since there is snow."*

Higher-level inferences were those that addressed the "big ideas" and causal relationships. These inferences make reference to underlying ecological themes or big ideas within environmental science—interdependence, adaptation, cycles, ecosystems, and pollutants. (See Exhibit 8.2 for definitions.) Examples of a higher-level inference include the following student responses:

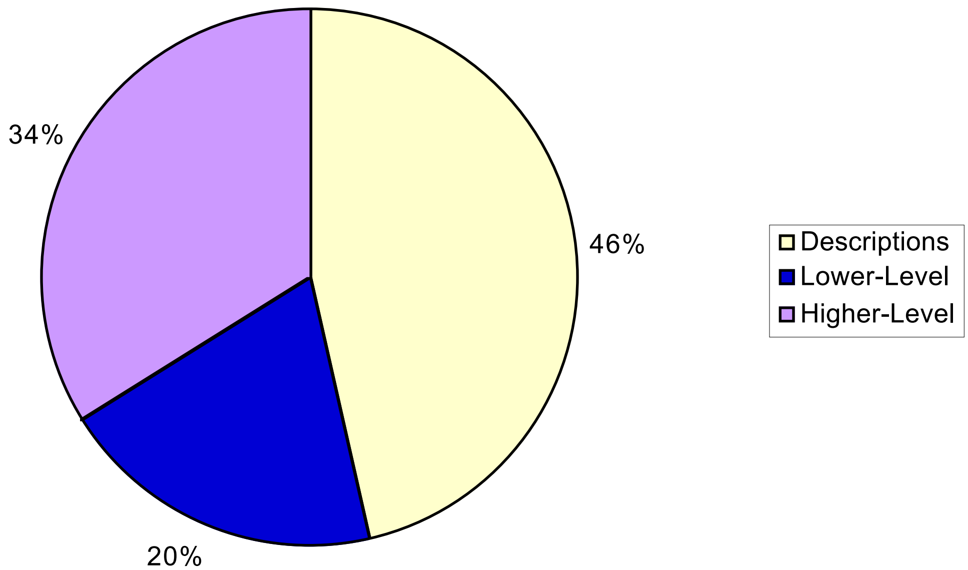
> *"The fresh water from the mountain provides an underwater ecosystem, which provides its inhabitants with food and water." (Inference: ecosystems)*
>
> *"The trees anchor down the soil so that it does not fall down into the water." (Inference: interdependence)*
>
> *"As the clouds collect more and more water droplets, they begin to release precipitation." (Inference: cycles)*

Two members of the evaluation team coded student responses. A subset of responses was coded by both researchers independently, to establish the reliability of the coding scheme. Interrater agreement was .74. Figure 8.1 shows the proportion of student responses falling into each category.

Exhibit 8.2
Definition of "Big Ideas" of Environmental Science

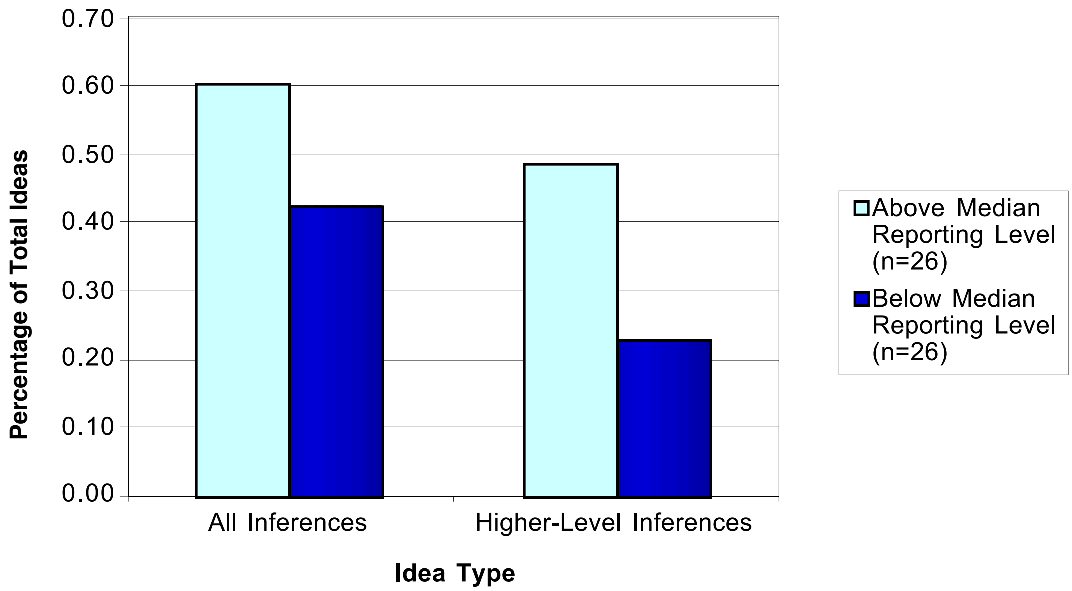
- ***Interdependence*** is the idea that the elements are interconnected, that a balance exists within the environment. It includes any reference to or evidence of seeing "patterns" within the environment.
- ***Adaptation*** refers to ideas about how organisms adapt to their environment—for example, a physical characteristic or behavior that allows an organism to adjust to or accommodate certain conditions of a particular environment.
- ***Cycles*** refer to the idea that all components of the Earth's biosphere are used and reused. One example is the water cycle—the continuous movement of water between the Earth's surface and the atmosphere. The oxygen cycle refers to the idea that all animals and plants live within the Earth's biosphere, which extends just above and just below the Earth's surface. Gases in the Earth's atmosphere, water, etc., can all be reused by organisms because they are recycled. For example, plants and animals recycle resources in the atmosphere through respiration (in animals) or photosynthesis (in plants).
- ***Ecosystems*** refer to the idea that there is a distinct area that combines living (biotic) communities with nonliving (abiotic) environments such as sunlight, soil, moisture, and temperature, and concern ways in which they interact.
- ***Pollutants*** refer to what happens when contaminants are introduced into the environment (substances that destroy the purity of the water, air, and land).

Figure 8.1
Proportion of Students' Idea Statements, by Type



All the students in this pilot study were drawn from GLOBE classes, but some of them were in classes that had reported extensive Atmosphere data while others were from less active GLOBE sites. We analyzed the student responses to see whether students in the two types of classes differed in their performance. Students' initial responses (in the "unprompted" condition) showed a significant correlation between the amount of data reported by their school and both the percentage of ideas that were inferences and the percentage that were higher-level inferences that referred to big ideas in environmental science, such as cycles, adaptation, interdependence, ecosystems, and pollutants. (The first correlation was .317, and the second .356, both significant at $p<.05$.) As shown in Figure 8.2, the difference between students drawn from classes that had reported more data and those from classes that had reported less data was greater for the higher-level inferences than for inferences overall. The more students in classes had reported Atmosphere data to GLOBE, the more likely they were to incorporate big ideas from environmental science into their descriptions of the image of Mt. Hood.

Figure 8.2
Relationship between Inference-Making and Data Reporting Level



Water Cycle Concepts

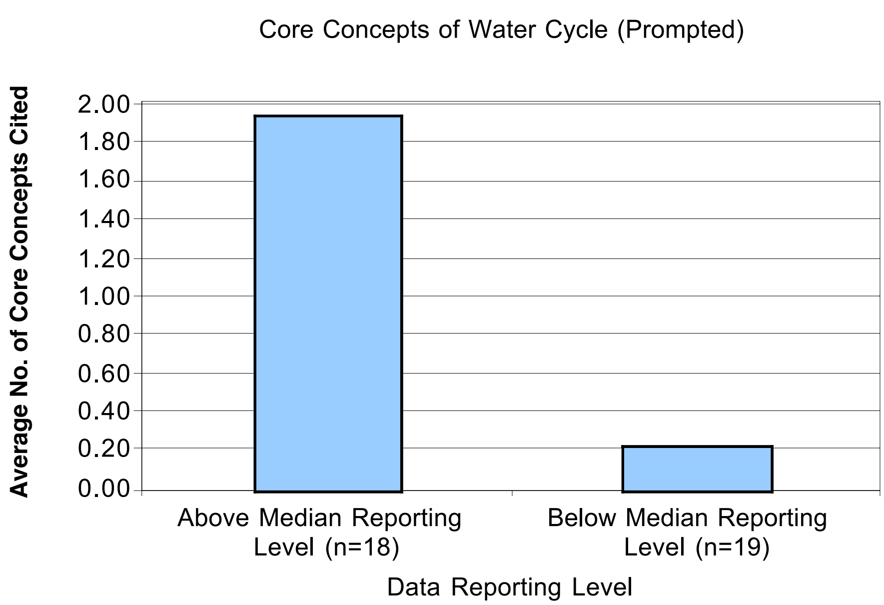
As in Year 3, we examined the role of prompts in students' responses to the Environmental Awareness task, comparing different student perceptions given different prompts. Within the "cycles" category of inferences, we coded students' answers for mentions of key concepts within the water cycle, in order to compare students' responses to the open-ended question with their responses to the question asking them specifically to discuss how the water cycle shapes the environment in the picture.

- *Evaporation* is the process in which a liquid—in this case, water—changes from its liquid state to a gaseous state.
- *Condensation* occurs when a gas is changed into a liquid. Condensation occurs when the temperature of the vapor decreases.
- *Precipitation* occurs when the temperature and atmospheric pressure are right and the small droplets of water in clouds form larger droplets that fall to the earth.
- *Surface runoff* is the water that returns to earth as precipitation, runs off the surface of the land, and flows downhill into streams, rivers, ponds, and lakes.
- *Infiltration* is an important process in which rainwater soaks into the ground, through the soil and underlying rock layers.

- *Transpiration* is a process by which water evaporates through plant leaves. As plants absorb water from the soil, the water moves from the roots through the stems to the leaves. Once the water reaches the leaves, some of it evaporates from the leaves, adding to the amount of water vapor in the air.

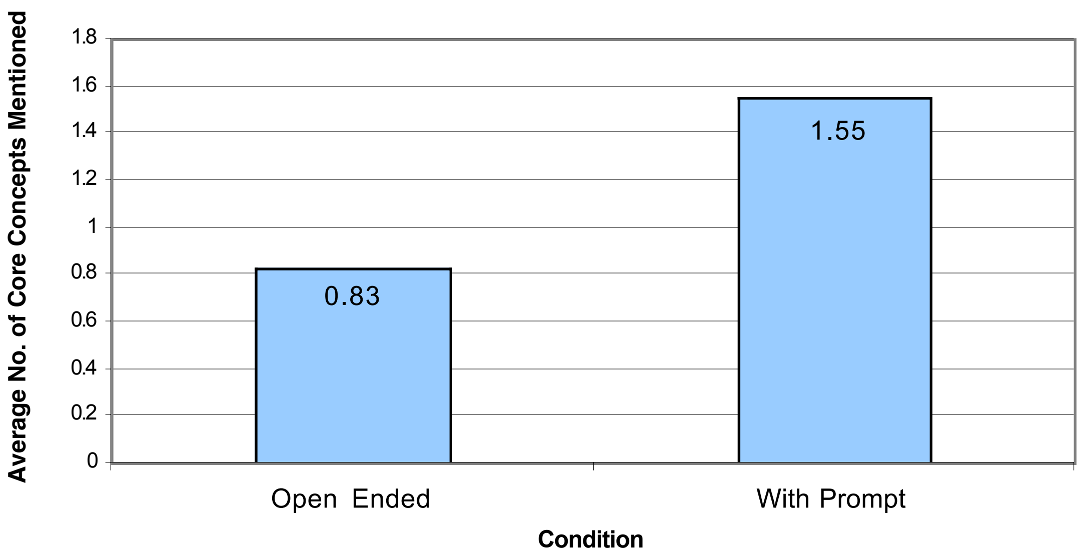
Among high-implementing GLOBE schools, we found a significant positive correlation between amount of data reporting and the number of core concepts students mentioned about the water cycle. In other words, the more that schools reported Atmosphere readings, the more likely their students were to identify key concepts about the water cycle. This correlation was .468 in the unprompted condition and .384 with prompts (both significant at $p < .05$). The fact that the correlation was higher in the unprompted condition suggests that GLOBE experience brings key environmental ideas, such as aspects of the water cycle, to greater prominence in students' thinking, such that they access these ideas without adult prompting. Figure 8.3 shows the number of water cycle concepts cited by students in classes above and below the sample median in terms of GLOBE data reporting.

Figure 8.3
Relationship between "Core Concept" Statements and Data Reporting Level



There was a significant effect of providing a prompt to students to help them generate answers that specifically identify the core concepts of the water cycle. Asking students to discuss how the particular environment in the image was shaped by the water cycle increased the average number of concepts significantly (p<.05). As Figure 8.4 shows, the average number of core concepts mentioned jumped from 0.83 to 1.55 from the unprompted to the prompted condition of the task.

Figure 8.4
Core Water Cycle Concepts Mentioned by Students, by Condition



The mediating role of prompts in supporting students' environmental inference-making is consistent with our findings in Year 3. Last year, we found that students in GLOBE needed fewer specific prompts than did non-GLOBE students to support their thinking about environmental relationships; the general prompt to think about the kinds of data collected in GLOBE and describe the image was enough to elicit higher-level inferences about the water cycle. This year, we found that for all students, providing a specific prompt helped improve their likelihood of demonstrating environmental understanding as measured by the Environmental Awareness task.

The Olympic Task

In the Olympic task, we asked students to select from among five cities the ideal site for a future Winter Olympics, on the basis of climate-related criteria set by the Olympic Committee. We provided students with the following guidelines to help them make their decision:

- The mountains need to be at least 1000 meters tall, as measured from the base of the mountain.
- There needs to be at least 1000 mm of snow from December to February, so that there will be enough snow on the ground in February, when the Olympics will be held.
- The base camp should be warm and sunny, so that people can enjoy watching from outside.
- The mountain peaks should be cold enough so that snow falling doesn't begin to melt and turn to ice.
- Latitudes closer to the equator are preferred, so long as there's enough snow to meet the criteria.

Students were then given climate data and data about the elevation and latitude of each of five cities and asked to select the ideal site for the next Winter Olympics. The actual site for the 2002 Winter Olympics, Salt Lake City, was to be taken as the default choice: students were asked to determine whether there was a city that was a better site than Salt Lake City, given these climate-based criteria.

Among the cities in this task, one met or exceeded all of the criteria. Although this city did not have the tallest mountains or greatest snowfall, it did meet the Olympic Committee's guidelines for both. Because there was both a clear choice for the best site given the criteria provided and because multiple cities surpassed Salt Lake City on some dimensions, our analysis focused both on students' answers (whether or not they chose the best site) and on the reasoning and evidence they used to support their answers. We believe that the graphs students created and arguments they made to convince the committee that theirs was the best city to host the Olympics tell more about students' reasoning and data analysis processes than the city choices themselves. The graphs and arguments show the extent to which students' decision-making was guided by both the data and the guidelines. We expected that more experienced GLOBE students would create more and better arguments on their city's behalf, paying close attention both to the supporting evidence and to evidence that might point to another city as the best choice for the Winter Olympics.

Number of Correct Answers

Of the student groups that participated in the pilot assessment, only high-implementing schools within GLOBE were able to complete the Olympic task. It may have been that the task took more time than was available for other students, or that they found the task too hard. We plan to explore this issue with the teachers who participated in the assessment this fall, when they return to school. Thus, we were not able to compare low- and high-implementing classrooms, but we were able to compare results of middle school students and high school students who completed the task.

Contrary to expectations, middle school students were more likely than high school students to choose the ideal site for the upcoming Winter Olympics. Two-thirds of the student groups (consisting of three students each) from middle schools got the correct answer, whereas just over half of the high school groups got the correct answer (see Table 8.1).

Table 8.1
Correct Answers to the Olympic Task, by Level

Level	*Number of Groups Completing Task*	*Number of Correct Answers*	*Percent of Correct Answers*
Middle schools	12	8	67
High schools	20	11	55

Although these results are surprising, the total number of student groups who completed the task was small, and these differences are not statistically significant. We believe a closer look at the reasons behind students' choices yields a more accurate portrait of students' skill in problem solving and data analysis with GLOBE-like data.

Analysis of Students' Reasons for Their Choices

As part of their answers to the Olympic task, students were asked to produce at least two graphs that compared their city with Salt Lake City or compared Salt Lake City with another city of their choosing (if they indicated Salt Lake was the best site for the Olympics). Students were also asked to submit an explanation of why the graph they chose supported their argument, as part of an on-line presentation they were to develop for the Olympic Committee. The graphs and reasons constitute the *backing* (Toulmin,

1958) to students' arguments and represent their attempts to ground their problem solving in the data and guidelines provided.

As Table 8.2 shows, high school students were more skilled in providing evidence to support their decision-making than were middle school students in GLOBE.

Table 8.2
Graph Production and Consistency in the Olympic Task

Level	*Average Number of Graphs Produced per Group*	*Overall Percent of Graphs Consistent with Argument*
Middle schools n = 12	0.83	40
High schools n = 20	1.95	74

High school students, on average, created more graphs than middle school students created. They produced close to two graphs per answer, as was required by the directions, whereas middle school students produced, on average, less than one graph. In short, they were able to provide more evidence to support their choice of cities for the Olympics. High school students also were more likely to present choices and data that went together; that is, the graphs they chose to produce actually supported their choice of city for hosting the Olympics. Almost three-fourths of the high school students produced graphs in which their chosen city was better than the city with which they compared their choice on the given parameter graphed, whereas only 40% of the middle school students did so. Moreover, high school students were more likely to produce the *best* graph to support their decision. In other words, if they chose a particular city, they were more likely to create a graph comparing that city with Salt Lake City on the parameter on which their choice had the biggest advantage.

The explanations students gave for why their graphs supported their decision in some cases reflected different levels of skill in using the criteria set by the Olympic Committee to guide their decision-making. For example, one high school group's answer reflected their sensitivity to the need for warmth at the base camp, sunshine, and snow on the peaks. Their graph, moreover, compares their city's mean days of sunshine with the mean days of sunshine in Salt Lake City, a parameter in which their choice is far superior to Salt Lake City:

> *The Olympic Committee would like the base camp of the Olympics to be fairly warm so that people do not get too cold while they are watching the events. As the graph shows, [City A] has an average of 11 days of sunshine in February, whereas Salt Lake City has a menial five days of sun. There is a much better chance of the weather being better in [City A] than in Salt Lake City. The snow also maintains during the warm days because it is still below freezing at the mountain peaks.*

Another group of students chose Salt Lake City as the best site and presented a graph comparing the base camp temperatures (maximum) of Salt Lake City and another city. Although these students did not pick the best site, according to the criteria, their graph supported their choice, as did the explanation they gave:

> *Since the temperature at base level should be at least warm, and if possible, sunny, this proves that Salt Lake City is cool enough compared to [City B], which is too cold –3 degrees Celsius. Also, Salt Lake City has up to 5 days of sunshine in February. This keeps the players and spectators more comfortable than if they were at [City B].*

At the same time, some groups of students were far less successful in using the guidelines to back their choices. They tended to rely on facts that, although they may have been accurate, did not reflect the constraints set forth by the Olympic Committee. For example, one group of students wrote:

> *"The more sun light the more snow that melts so [City C] would be great because there is little sun light."*

For these students, the significance of the mean days of sunshine is the likelihood that the sun will melt the snow. Although the sun may in fact contribute to the melting of the snow, this group of students failed to take into consideration the guideline that the more sunshine at the base, the better the Olympics would be for spectators. This kind of response was more typical among middle school students, whose reasons and backing for their decision about where to host the Olympics were often not as well coordinated with the climatic evidence and the committee's guidelines.

Discussion

The findings from this year's pilot of a Web-based assessment environment suggest that GLOBE activities can play a significant role in developing students' environmental awareness and data analysis skills. Although our sample size was limited by the pilot nature of our study, our findings are consistent with Year 2 and Year 3 findings, which indicated that GLOBE students had a more accurate conception of the work of scientists and also were more environmentally aware, from a cognitive and scientific perspective, than comparison students. We believe that GLOBE data reporting contributes to these findings in a number of ways.

First, students who collect data often and consistently, as all schools in our high-implementing sample did, are likely to be exposed to a variety of problems involving data. For example, they are more likely to encounter (and potentially discover and correct) mistakes in reporting and anomalies in the data that require interpretation and analysis. These experiences may make GLOBE students more attentive to the relationships among variables, as required by our Olympic task.

Second, regular practice in collecting data may make the concepts of environmental science more salient in students' thinking. GLOBE students who take Atmosphere measurements are likely to pay greater attention to changes in the weather and even to watch television weather reports differently than other students, as some GLOBE teachers and parents have told us. Their lens is one brought from GLOBE, and repeated practice may increase the likelihood that they perceive their environment through the lens of science. This interpretation is consistent with the GLOBE students' many references to cloud cover, temperature, and the presence of snow in the Mt. Hood scene, as well as the inferences students made about the effects of climate on vegetation type, river flow, and water temperature.

A third possible reason for our findings is that GLOBE teachers who use the protocols regularly are also likely to be implementing multiple learning activities with the protocols and integrating the activities into a curriculum that pays close attention to the big ideas of environmental science. In next year's assessment, we will investigate this hypothesis by collecting more data on teachers' implementation of GLOBE and analyzing relationships between implementation variables and student outcomes. We anticipate that the teacher's role in adapting GLOBE to meet local curricular goals is one of the most important keys to GLOBE's success in fostering students' understanding of the environment and increasing their knowledge of big ideas in environmental science.

Chapter 9. Discussion and Recommendations

After 4 years of operation, GLOBE has reached a stage of maturity, yet it remains open to continued evolution and the participation of new researchers, teachers, and students. In this chapter, we first describe the evolution of the GLOBE partner model. Next we discuss what appears to be an emerging "steady state" in terms of numbers of new teachers trained and amount of GLOBE activity in the context of changing internal and external factors affecting GLOBE. We conclude with a description of issues facing GLOBE and recommendations for further program refinement.

The Partner Model

GLOBE's creation as an international science and education program called for a combination of rigor (with regard to the scientific data collection protocols), scalable infrastructure (for the involvement of students and teachers worldwide), and flexibility (permitting individual country partners to implement GLOBE at the grade levels and schools they deemed most appropriate). This combination of program structure, shared infrastructure, and flexibility proved so successful at the international level that the GLOBE Program office decided to use it within the United States in the form of GLOBE "franchises" for nonprofit institutions interested in recruiting, training, and supporting GLOBE teachers in their service areas.

The partner model appears to be a viable, scalable strategy for program growth. The Partner Survey reports suggest that GLOBE partners are going beyond the norm in providing supports and continuing contact with the teachers they have trained. More than 60% of GLOBE partners report providing instrument kits for the schools of teachers they have trained. More than half have provided assistance in setting up or using computers; a similar proportion have provided their teachers with a mapping between GLOBE content and the content of required curricula and assessments. An impressive 80% of partners report making personal contacts through telephone or e-mail with the teachers they have trained. Over 60% go out to the schools of their trained teachers; a similar percentage host meetings or conferences where previously trained teachers can share experiences. Anecdotal data from conversations with GLOBE partner coordinators support these survey findings in suggesting that GLOBE partners view their mission as more than moving teachers through the training activities needed for certification. Rather, the partner organizations conceive their role as one of providing ongoing supports for teachers' involvement with the program and improvement of their science teaching and data contributions.

Interpreting Trends in Training and Implementation Rates

The good news concerning the high level of teacher support activities should not deter a careful look at program trends for areas that might need improvement. GLOBE has been training large numbers of teachers since 1995. Over the past 2 years, more than 2,400 teachers have completed GLOBE training annually. Looking at the data presented in Chapter 4, a reader would be likely to ask why, despite the continuation of this level of training activity, the number of schools contributing data to the GLOBE Student Data Archive has leveled off at around a thousand schools per month (international involvement appears to be more stable than that in the United States). It appears that new schools commencing data-reporting activities are offset by those no longer participating. Although we know from prior teacher surveys that teachers can use many aspects of GLOBE with their students without necessarily contributing data to the GLOBE database (an estimated 24% of teachers having students collect data do not have them report it to the GLOBE database), data contributions remain not only a significant outcome in their own right but also the most convenient available proxy for program participation. In this section, we consider and discuss some of the contextual factors likely to be contributing to the leveling off of GLOBE data reporting.

Increased Emphasis on Training Multiple Teachers per School. In GLOBE's first year of operation, program directors sought to maximize GLOBE's diffusion by training a single teacher from each participating school. As the multiple challenges involved in launching this complex program at a school became apparent, and as GLOBE expanded to include more data collection protocols and learning activities, emphasis switched in April 1996 to trying to train multiple teachers from each GLOBE school to maximize the likelihood of an effective, sustainable effort with data continuity (Means et al., 1997). This change was a conscious decision to stress quality of school implementations over quantity. The proportion of newly trained teachers who are second or third teachers from their schools has been increasing over time (Means, Coleman, & Lewis, 1998). Hence, at least part of the leveling off in number of schools reporting data each month can be attributed to the focus on training to support broader implementation of GLOBE within each participating school.[1]

If we look at the number of data *reports* submitted per month or per year rather than the number of *schools* reporting data, there appears to be an increase, rather than just a steady state, between the 1997-98 and 1998-99 academic years. The meaningfulness of this variable in longitudinal analyses is undermined, however, by major changes over time in the data reporting forms, including the requirement instituted in 1998 that a Solid Precipitation reading, even if it is 0 for no snow, be submitted every time an air temperature reading is submitted. Our conclusion is that the leveling off of data reporting, although tempered by modest improvements in the diversity of types of data reported, is a real phenomenon that is partly but not entirely explained by the increased emphasis on training multiple teachers per school. (See the discussion of changes in this variable over time in Chapter 4.)

Teacher Turnover. Another factor affecting not only GLOBE but any innovative education program is the high turnover rate in the teaching profession, as described in Chapter 6. Each year, roughly 13% of U.S. teachers leave their schools, either for other schools or to quit teaching (NCES, 1997). The GLOBE Program, then, must train enough new teachers each year to replace the 13% of all previously trained teachers who can be expected to leave their schools or to leave the teaching profession altogether. The implications of this turnover rate for an educational innovation are staggering. Based on these national turnover rates, if the proportion of trained teachers who subsequently implement GLOBE has remained constant at 60% (see Year 2 evaluation report), GLOBE in the United States would have needed to train 960 teachers in 1998-99, for example, just to replace those teachers trained earlier who could be expected to no longer be teaching in the schools where they were located when they received GLOBE training. Schools do not regularly inform GLOBE when a GLOBE-trained teacher has left the school. Many of the “second” or “third” teachers trained at GLOBE schools, as indicated in the GLOBE database, may in fact be replacements for teachers who have left.

A factor that may have further exacerbated teacher turnover in 1998-99 is that when teachers were recruited and trained for GLOBE’s first full school year (1995-96), they were asked to commit for 3 years of participation. These teachers would have completed

[1] GLOBE data reports are submitted and archived according to the submitting school (not the teacher or class). Hence, a given school’s record does not show how many teachers had classes contributing to the data archive.

their participation at the end of the 1997-98 school year. It is not known to what extent early GLOBE teachers chose to go on to other activities because they sensed they had "completed" their mission. (This is one of the questions we will address in the spring 2000 Teacher Survey.)

The GLOBE Program has been grappling with this problem of U.S. teacher turnover for several years now. In addition to encouraging schools to have multiple teachers trained (so that the school's program is less dependent on a single teacher), GLOBE encourages schools whose GLOBE teacher leaves to get a new teacher trained as soon as possible and encourages GLOBE-trained teachers who switch schools to establish a GLOBE program at their new school. In February of each year, GLOBE sends a questionnaire to all GLOBE teachers asking for information on which GLOBE teachers are at the school and for names of any GLOBE teachers who have left the school. The correspondence urges any GLOBE teachers who are planning on leaving their schools to take responsibility for developing a plan to identify and obtain training for another teacher who can take over the program. Because GLOBE is not part of the school system, however, its receipt of notification that a GLOBE teacher is leaving a school depends entirely on having someone within the school take the initiative to contact GLOBE. Local franchises (especially those that place GLOBE equipment in the schools of teachers they have trained) have greater opportunities to check on schools' GLOBE program staffing for the upcoming school year.

Increased Accountability Pressure. In the Year 2 evaluation report (Means et al., 1997) we described the perception on the part of some second-year U.S. GLOBE teachers that increased emphasis on state or local curriculum standards was reducing the amount of time they could justify devoting to GLOBE activities within their classrooms. Since that time, the emphasis on curriculum standards as a mechanism for improving educational achievement and the concomitant pressure to raise student scores on associated state and district tests have continued to increase (Baker, 1999) in nearly every state.

Education researchers across the country are reporting that the greater emphasis on teaching to the content of state and district tests is making it more difficult to interest teachers in programs such as GLOBE. Mary Ann Blankenship of the National Education Association was quoted in a recent issue of *Education Week:* "What I hear from teachers is that, unless we can show them a direct correlation to the standards that they live and die with every day, it may be the best content in the world, but there's just no way they have time to use it" (Hoff, *Education Week*, Technology Counts, p. 51). In an on-line discussion forum sponsored by the Center for Innovative Learning Technologies, Ed Coughlin of the Milken Family Foundation concurred: "In the study that we completed for the Virginia legislature, we were constantly apprised by teachers that they simply did not have time for any instructional strategy that was not linked directly to the Commonwealth assessment. In Florida, too, we are being informed by principals that 'If it's not on the FCAT, we're not interested.'" The pressure to focus on the content of high-stakes assessments may well be deterring some teachers from devoting significant time to GLOBE activities.

Changing Population of Trainees. Another possible factor in the leveling off of GLOBE data-reporting schools involves possible changes in the kinds of teachers who are taking GLOBE training. If the population of U.S. trainees is changing, it is quite possible that their intentions and needs are different from those of earlier trainees.

In GLOBE's early days, teachers who wanted to implement the program had to spend a consecutive 4 days in training, often at some distance from their homes and schools. Many of these teachers knew that they would have to champion the effort to get Internet connectivity for their schools if they were going to fully implement the program. Arguably, GLOBE would have appealed to the most innovative and resourceful of teachers, especially at a time when there were few other Internet-based inquiry-oriented educational programs available. With the program's maturation and the shift to franchise training, teachers can now receive GLOBE training near their homes. They may be able to complete the program on Saturday mornings or as part of the continuing education they need for recertification. Thus, for many U.S. teachers, the "hurdles" teachers must overcome to participate in GLOBE training are lower than they once were, and it seems reasonable to suppose that a wider cross section of teachers is participating in training for a wider range of reasons. (In fact, anecdotal reports suggest that some teachers are taking GLOBE training at their local franchise with no expectation of actually implementing the program in their classrooms.)

Although a larger portion of recent trainees may never report any data to the GLOBE database, it is quite possible that there are enhancements to these teachers' understanding of Earth science and to their instructional practices stemming from their involvement with GLOBE. The 2000 Teacher Survey will include a large sample of these teachers to permit an assessment of whether or not GLOBE has influenced their science teaching.

A Rival Hypothesis: Differences in Training Effectiveness

With the shift toward franchises as the primary mechanism for training GLOBE teachers within the United States, skeptics may dismiss the contextual factors discussed above in favor of questioning whether there has been a change in the effectiveness of teacher training. Current training practices may differ in quality or place reduced emphasis on the data collection protocols. Although training quality is not simple to measure, the data that are available do *not* support the interpretation that training quality is lower at franchise sites. Franchise training is similar to GLOBE contract training in terms of involvement of university staff, scientists, and active teachers. At most franchise sites, the amount of time spent in training protocols appears to be consistent with the guidelines for contract training. Moreover, in our analysis of GLOBE franchise training follow-up practices, we found that GLOBE franchises were doing significantly more to follow up on their teacher training than were the 34 federally funded science and technology teacher enhancement programs nominated as exemplary that were studied by Ruskus and Luczak (1995).

Emerging Issues and Recommendations

Each year, the evaluation team members have reflected on their data and on their experiences observing GLOBE training and implementation to identify issues for GLOBE Program office consideration and make suggestions for program improvement. This year, our recommendations focus on five issues pertinent both to improving the program and to maximizing the payoff from investments in GLOBE:

- Assessing the trade-off between investments in training and investments in follow-up activities.
- Strengthening the involvement of school administrators in supporting GLOBE programs.
- Providing examples of articulated, developmentally appropriate GLOBE implementations.
- Helping current and prospective U.S. GLOBE teachers deal with pressure from external accountability systems.
- Continuing to strengthen student involvement in all phases of science investigation.

Assessing the trade-off between investments in training and investments in follow-up activities. GLOBE partner programs face a set of trade-offs as they make decisions about where to invest their energies and resources. To increase the number of classrooms in which GLOBE is implemented, GLOBE partners can either try to bring as many new teachers as possible into the training pipeline or invest in follow-up activities and supports to maximize the likelihood that those who have been trained will actually implement the program. Our Partner Survey data, when viewed in the context of data from other federally sponsored science and technology teacher enhancement programs, suggest that GLOBE partners already do considerably more than average in terms of providing follow-up support. We suspect that the fact that the GLOBE Program by its very nature has a publicly available, continually monitored index of participation—school data reporting—is responsible for this unusually strong emphasis on follow-up support. By analyzing the specific support factors that are most effective in producing and sustaining teacher involvement, the GLOBE Program can provide franchises with information that will help them make trade-offs and refine their practices. As more U.S. franchises establish a track record of trained teachers, the evaluation team will address this need.

In addition, investment in evaluations at the individual partner level (as is already done by some of the international partners and a few franchises) can provide data for individual programs' use in making decisions concerning the settings in which GLOBE is most likely to flourish and the kinds of support and follow-up their teachers need most.

Strengthening the involvement of school administrators in supporting GLOBE programs. It has become increasingly clear that school administrator support (from principals, department chairs, and potentially district curriculum specialists) is important in sustaining GLOBE programs within schools. The discussion of teacher turnover rates above implies the value of maintaining ties with administrators who can champion the GLOBE program at times of staff changes. In addition, as noted in previous evaluation reports, if multiple teachers are to coordinate GLOBE activities, they need time for joint planning and program coordination. Administrators control the resources (time allocations and professional development funds) needed to support such collaborative planning. Evaluations of earlier educational innovations have identified the practices of training multiple teachers per school and administrative support and resources for trained teachers after they return to their schools as two key success factors (U.S. Congress, Office of Technology Assessment, 1995). Many GLOBE franchises require principals to sign a letter indicating that they will support the efforts of the teacher entering GLOBE training, but the nature of that support is generally left unspecified. Involving principals more directly in GLOBE training, extracting more concrete commitments of the ways in which they will support teachers after GLOBE training (e.g., the agreement to provide an aide or supported time for planning GLOBE activities, etc.), and developing channels for ongoing communication with principals are some of the strategies franchises might consider for maximizing the likelihood that the teachers they train will have the resources to mount and sustain an effective GLOBE program.

Providing examples of articulated, developmentally appropriate GLOBE implementations. The GLOBE Program offers an infrastructure, including a communal database, information and instructional resources, and training but leaves the specifics of implementation up to individual schools and classrooms. The virtue of this strategy is flexibility. GLOBE has been implemented not only around the world but in grades from kindergarten through early college and in settings as varied as urban private schools, residential schools for the visually impaired, science museums, and juvenile halls. There is a potential downside to such adaptability, however. GLOBE offers an extensive array of resources but leaves to the individual teacher the task of determining how to coordinate GLOBE components with each other and with local and state curricula to build a coherent educational experience. The magnitude of this effort should not be underestimated.[2]

For the next edition of the Teacher's Guide, we recommend review and revision by an experienced team of science educators, including one or more with developmental psychology expertise, to build recommended GLOBE sequences of activities and protocols that fit together conceptually and build in developmental stages appropriate for different levels of schooling. These sequences, of course, would be suggestions rather than mandatory combinations, and schools and teachers would surely adapt and modify them to fit their own concepts of good teaching and their local curricula and student populations. Nevertheless, they would provide a starting place for building a coherent

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[2] Although GLOBE franchises and others have made efforts to support curriculum integration by mapping GLOBE protocols and learning activities onto state standards, most of the mappings have been done at a superficial level, looking for similarity in the topics covered. Such mappings can be highly misleading. When SRI analysts compared the 1997 GLOBE Teacher's Guide with those chapters of a popular environmental science book that had titles suggesting GLOBE relevance, only 20% of the content was judged as really overlapping in terms of intended learning outcomes.

program and would help teachers, schools, and districts make intelligent choices about how to implement GLOBE.

The GLOBE Program has already taken several steps in this direction with the guidelines for developing learning activities and the cross-team meeting for investigators developing learning activities held in Menlo Park in January 1999. It is always difficult to achieve coherence with highly distributed materials development, however, and the multiple grade levels addressed and the multitude of disciplines involved in producing GLOBE materials greatly heighten the challenge.

Helping current and prospective U.S. GLOBE teachers deal with pressure from external accountability systems. The GLOBE Program is sensitive to teachers' needs to justify devoting time to GLOBE activities within the context of state and local curricula. Although the GLOBE Program itself does not deal with curriculum standards, it has encouraged franchises to relate GLOBE activities to state and local curriculum frameworks and to share this information with the teachers they recruit and train. Our discussion of this issue above suggests that relating GLOBE to curriculum standards and frameworks alone will not be sufficient. The real rub is coming from broad-scale assessments, particularly those with accountability consequences (such as teacher pay, school takeover, or even job loss). Moreover, principals and district administrators, whose support will be critical for the program's long-term survival, are even more sensitive than teachers to the consequences of test performance. GLOBE franchises can examine the relationship between GLOBE content and activities and the contents of the assessments given in their state or local districts. Our experience suggests, however, that reviewers who have not been trained in assessment often have difficulty identifying the skill, knowledge, or strategy a particular item really measures (in fact, this task is difficult for experts, as well).

An examination of some of the more widely administered tests for consistency with GLOBE content would prove helpful to many GLOBE franchises. We are not suggesting that GLOBE be modified to fit the content of statewide assessments but rather that those areas of overlap, where state and district assessments are tapping skill areas emphasized in GLOBE, be well understood and communicated.

Articulation of these areas of overlap would help teachers see how GLOBE can be an alternative approach to teaching skills and content for which they are being held responsible. In addition, this articulation could make the GLOBE materials more teacher friendly. For example, highlighting the mathematics concepts and skills used in each of the GLOBE protocols and related activities would help teachers judge the applicability of those materials for their students. Teachers would know what mathematical concepts and skills can be practiced through the protocols and would be able to judge their students' readiness for these activities.

Continuing to strengthen student involvement in all phases of science investigation. For several years now, GLOBE has been trying to provide students with involvement in science inquiry that extends beyond the process of collecting and recording data. It has become clear that, at present, GLOBE is very dependent on the inclination and skill of the individual teacher in providing these experiences. The GLOBE Program has proceeded on multiple fronts to support teachers in providing this meaningful context. The 2000 Teacher's Guide will have an increased emphasis on data analysis and interpretation and on communicating findings. Classroom assessment tools for each investigation area will focus on these skills. In addition, the GLOBE Program is now recommending that 25% of the time spent on teacher training be devoted to helping teachers learn how to support their students in planning, executing, analyzing, and communicating research investigations. Features added to the GLOBE Web site in recent years, such as the graphing capability and the Student Investigations journal, give students tools for using GLOBE data in their own investigations and for reporting those investigations to a wider audience. This aspect of the Web site could be further enhanced by adding a section where students can collaborate during the phases of posing scientific questions and puzzling through approaches to addressing them. An on-line student discussion group or joint lab notebook (structured as a hypermedia database) could be added to the current School To School Page, which allows school to sign up for joint investigations with other GLOBE schools. The CoVis Project (Edelson et al., 1995) offers this kind of electronic workspace for students working on environmental science investigations. Students can pose a question within this on-line shared notebook and link it to competing conjectures about the questions posed by other students from different schools. A dynamic site where students could pose questions and ideas informally could both stimulate interest and enhance involvement in the multiple aspects of science inquiry.

Another implication of the increased emphasis on involving students in data analysis and interpretation is the need to examine the usability of the interface to the data archive. The experiences of SRI researchers developing analytic tasks involving student use of GLOBE data and of the teachers in whose classes we have pilot tested those activities suggest that considerable labor is required to compare data sets over time or across different study sites. In addition, the current GLOBE graphing tool creates very complex graphs, which younger students have difficulty interpreting. We would recommend research on how students and teachers are using the GLOBE Web site and the features they find most helpful and those they find most difficult to use.

Summary

In summary, GLOBE appears to be at a new stage in its evolution. The program is now affecting practice in thousands of classrooms around the world. GLOBE is both becoming more widespread internationally and successfully transitioning to a "franchise" strategy within the United States. It now seems clear that there are numerous organizations within the United States interested in recruiting, training, and supporting GLOBE teachers, and that a significant number of these organizations are capable of marshalling the resources needed for these activities. The challenge for GLOBE today is to provide even better support for high-quality classroom implementations. The franchise training model is taking off in terms of number of teachers trained, and survey responses suggest that many of the programs are exemplary in terms of providing a large number of supports for newly trained teachers. These efforts should continue, with franchises sharing effective strategies and continuing to add to their support efforts.

At the program level, we recommend support for improving the coherence of GLOBE offerings and the articulation of areas of compatibility between those offerings and the learning goals emphasized in state curriculum standards and accountability systems. Further, GLOBE is committed to supporting teachers' efforts to involve their students in all phases of scientific investigation. Strategies for providing supports include enhancements to the GLOBE Web site, new Teachers Guide materials, and a reorientation of a significant portion of teacher training.

APPENDIX:

GLOBE Partner Survey

OMB No. 06480310
Approval Expires: November 30, 1999

A SURVEY OF GLOBE PARTNER COORDINATORS

Questions? Please contact Amy Lewis: alewis@unix.sri.com

Surveys should be returned to:

GLOBE Evaluation
SRI International
333 Ravenswood Avenue, BS 121
Menlo Park, CA 94025
U.S.A.

The public reporting burden for this collection of information is estimated to average 20 minutes, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to The GLOBE Program, 744 Jackson Place, Washington, D.C. 20503.

The information provided by respondents in this survey will be used to prepare summaries in aggregate form that do not identify individual respondents. The anonymity of respondents will be assured to the extent provided by law, including the Freedom of Information Act. Reasonable steps will be taken in the processing and analysis of respondent data to attempt to avoid any unintentional dissemination of information in which respondents and/or their responses may be identified.

Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirement of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB control number.

GLOBE Partner Coordinator Survey

Your Name: ______________________________________

Franchise or Country: ______________________________

Today's date: ___________________________ (month/day/year)

TARGETING AND RECRUITING PRACTICES

1. **Indicate the three primary targets for your GLOBE recruiting activities.** *[Put a "1" next to your most important recruiting target (where you spend the most time and effort), a "2" next to the second most important target, and a "3" next to the third most important target. Please rank no more than three targets.]*

_________ Whole districts (groups of schools)

_________ Individual schools

_________ Individual teachers

_________ Teachers already enrolled in an existing program.

_________ Preservice teacher education students

_________ Other (*describe):* __________________________

____

2. **What, if any, requirements do you have for those seeking to enroll in your training?** *(Circle all that apply.)*

0 No restrictions are placed on enrollment.

1 Schools must send a team with more than one teacher.

2 School principal must participate in training.

3 School principal must endorse training.

4 School or teacher's classroom must have connection to World Wide Web.

5 School or teacher's classroom must have, or promise to acquire, needed measurement instruments.

6 Other (*describe):* _______________________

____

TRAINING FORMAT

Questions 3-5 refer to the last GLOBE training you offered.

3. **How long was the last GLOBE training you offered?**

Number of training days: ___________ TOTAL number of training hours: ___________

4. **Was your last GLOBE training conducted over multiple sessions?** *(A session consists of consecutive training days with no non-training days in between.)*

0 No *Please continue with question 5.*

1 Yes *Please indicate:*

Number of sessions: _______ Elapsed time in days: __________

(First day of first session to last day of final session)

5. **How much time was devoted to each of the following topics during the last GLOBE training you offered?** *(Circle one number for each.)*

		No Time	1 Hour or Less	1 - 3 Hours	More Than 3 Hours
a.	Atmosphere Protocols	0	1	2	3
b.	Atmosphere Learning Activities	0	1	2	3
c.	Hydrology Protocols	0	1	2	3
d.	Hydrology Learning Activities	0	1	2	3
e.	Land Cover/Biology Protocols	0	1	2	3
f.	Land Cover/Biology Learning Activities	0	1	2	3
g.	Soil Protocols	0	1	2	3
h.	Soil Learning Activities	0	1	2	3
i.	Seasons Learning Activities	0	1	2	3
j.	GPS	0	1	2	3
k.	Use of GLOBE data reporting forms	0	1	2	3
l.	Use of GLOBE data visualizations	0	1	2	3
m.	Use of MultiSpec	0	1	2	3
n.	How to integrate GLOBE with local curricula	0	1	2	3
o.	Implementation planning	0	1	2	3
p.	Getting mentoring/feedback on implementation steps taken between training sessions	0	1	2	3

Questions 6-8 refer to the individuals who provided training at your last GLOBE teacher training.

6. How many GLOBE-certified trainers participated in your most recent GLOBE teacher training? ☐

\+

7. How many individuals *other than* GLOBE-certified trainers served as presenters for your most recent GLOBE training? ☐

=

☐ *Grand total A*

8. For these trainers and presenters, show the number with each type of *primary* organizational affiliation. *(Count each trainer only once.)*

College or University Faculty		*K-12 Schools*		*Other Institutions*		*Totals*
Education department	______	Elementary school (grades K-5)	______	Informal science education center (e.g., park or museum	______	☐ +
Science department	______	Middle school (grades 6-8)	______	Environmental agency (e.g., national weather service or soil conservation agency)	______	☐ +
Other departments	______	High school (grades 9-12)	______	Other	______	☐ =
Totals	☐	+	☐	+	☐	= ☐ *Grand total B*

Note: Grand total B for question 8 should be the same number as Grand total A for questions 6 and 7 combined.

SUPPORT ACTIVITIES AND STRATEGIES

Questions 9-11 refer to your typical or routine practices over time.

9. Which, if any, of the following supports do you typically provide to your new trainees? *(Circle all that apply.)*

1 Instrument kits

2 Computers

3 Assistance getting an Internet connection

4 Assistance setting up and/or using computers for GLOBE

5 Alignment of GLOBE activities with state or local curriculum or tests

6 Other (*describe):* ______________________

____

10. Which of the following support activities have you provided for those who have completed your GLOBE training? *(Circle all that apply.)*

1 Teacher listserv

2 Meetings, conferences to share experiences

3 Local GLOBE newsletter

4 Supplementary materials (e.g., implementation tips)

5 Personal contact with franchise/program staff through phone or e-mail

6 Site visits by franchise/program staff

7 Visits by designated GLOBE mentor or master teachers

8 Arranged contacts with scientists

9 Refresher training sessions

10 Participation incentives (e.g., equipment or recognition in return for reporting certain types or amounts of data)

11 Monitoring and feedback on data reporting contributions

12 Other (*describe):* ______________________

____

11. Have you implemented any other strategies that have proved particularly interesting or successful in fostering long-term involvement and high-quality implementation of GLOBE?

0 No

1 Yes *(If yes, please describe any such activities.)*

____

____

____

PERSPECTIVES

12. What benefits do you see in participating as a partner in the GLOBE program?

13. To what extent has fund-raising been a challenge for your franchise/country GLOBE program? *(Circle one.)*

1 Not a challenge
2 Minor challenge
3 Moderate challenge
4 Major challenge

14. Other than fund-raising, what do you see as the biggest challenges facing your franchise/country GLOBE program?

Thank you very much for your help in completing this survey.

If you have any further comments, you may use the space below.